Organizing for the Use of Space:

Historical Perspectives on a Persistent Issue

Roger D. Launius, Editor

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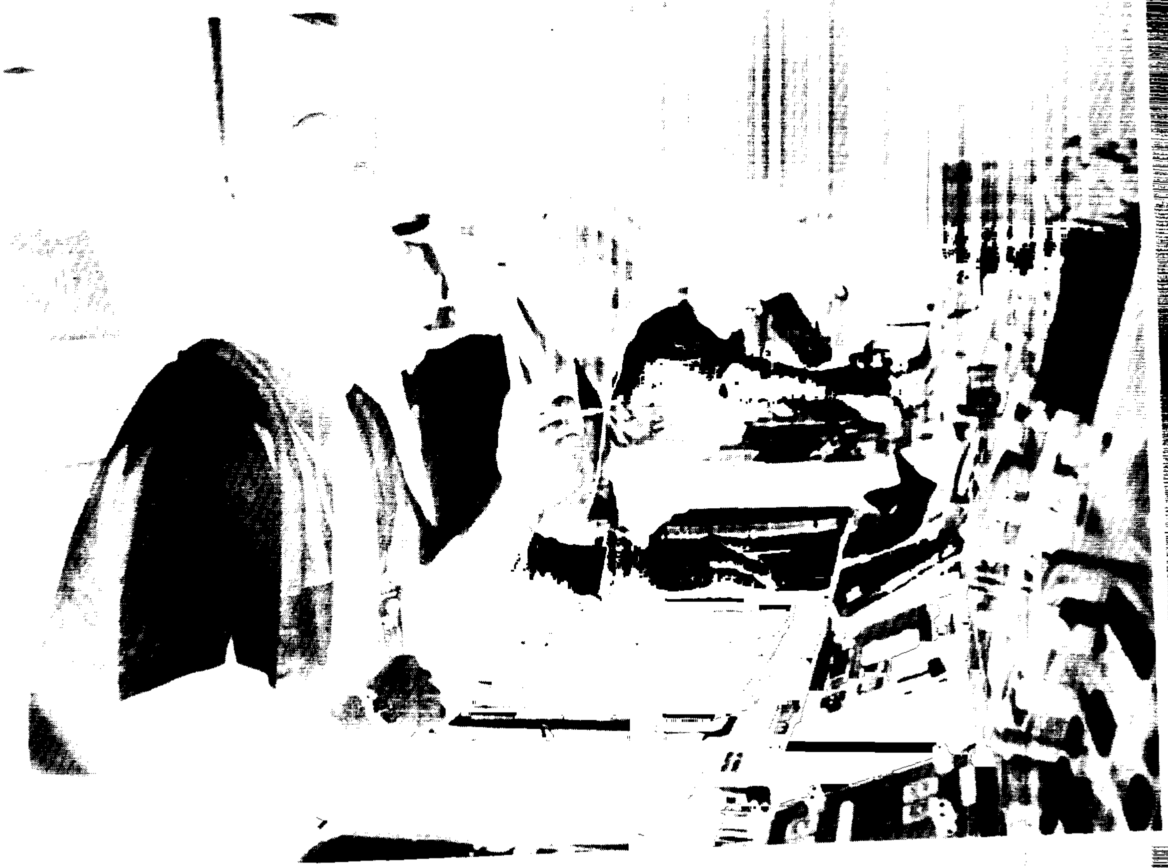

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Front Cover Illustration:

The epitome of space flight organization: Flight Directors John D. Hodge (left) and Eugene F. Kranz, at their console in the Mission Control Center at the Manned Spacecraft Center during the critical reentry maneuver of the *Gemini VIII* spacecraft into the Earth's atmosphere. Hodge and Kranz are Flight Directors for the National Aeronautics and Space Administration's *Gemini VIII* space flight. The spacecraft was returned to Earth during its seventh orbit. Crewmen on the flight were Astronauts Neil A. Armstrong, command pilot, and David R. Scott, pilot (NASA Photo 66-H-350).

Organizing for the Use of Space: Historical Perspectives on a Persistent Issue

Roger D. Launius, Volume Editor

R. Cargill Hall, Series Editor

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Dedication

To the Memory of T. Keith Glennan (1907-1995)
The First NASA Administrator
A Critical Leader in Organizing for the Use of Space

Preface

Slightly more than a half century ago the first tentative explorations into space learned that it was an environment in which the United States could conduct operations of benefit to the nation and its people. With the end of the Cold War between the United States and the Soviet Union in the 1990s, advocates of an aggressive space exploration program face a problem similar to what they encountered at the end of World War II. Then, as now, makers of space policy have been wrestling with the definition of a space program that does not have a strong defense component aimed at a large, powerful, and determined rival.

During the 1940s and 1950s three principal ingredients coalesced to bring to fruition the development of an aggressive civil and military space exploration and application program for the United States. The first of these was the development of an enabling technology, essentially rocketry and its attendant elements, that make possible travel into and through space. The second was an economic and industrial base sufficient to support the huge expenditures of funds necessary to sustain exploration in its nascent form before economies of scale brought down its cost in real terms. The third was the human will to carry out these efforts. These were motivated by adventure and romance, economics and idealism, pragmatism and politics depending upon the various makers of public policy and their interests. Indeed, a coalition of interests came together to support specific projects for different reasons. They were propelled in large measure by the Cold War rivalry of the United States and the Soviet Union, and the need to excel in space both militarily and from an international prestige perspective.

Because of the timely nature of space policy formulation for the United States at the end of the twentieth century, the History Committee of the American Astronautical Society organized a session at the November 1993 meeting to address the issues of formulations of space policy in earlier eras. It assembled a set of five presentations on the civil and military development of how and why space activities were organized and conducted for the period between the 1940s and the 1980s just as the Cold War was winding down. These five presentations, as well as additional perspectives added thereafter, have been consolidated into this publication for the benefit of a wider audience than those present at the annual meeting. The goal of this work, therefore, is to record in one place the historical observations about astronautical policy-making developments offered by individuals from broad and divergent backgrounds, with differing perspectives on events.

The first chapter in this book is an essay by J. D. Hunley that compares the organization and management efforts of the two major rocket development efforts in Germany and the United States in World War II. The German effort under Wernher von Braun at Peenemünde led to the successful development and operational deployment of the V-2 rocket against the Allies. The organization that became the Jet Propulsion Laboratory in Pasadena, California, also developed a smaller but significant rocket that saw important use in military and scientific circles at the end of the conflict and for several years thereafter. The structure and management of this technological effort at both sites in many ways set the stage for the later organizational and management structures that emerged to conduct space exploration and utilization in the post-war era.

In chapter 2 Howard E. McCurdy discusses the popular culture of Cold War America in the 1940s and 1950s, and how that milieu fundamentally affected the direction taken by policy makers in developing the key components of the U.S. space program. McCurdy finds that while most of those initially advocating space exploration did so largely for the thrill of adventure and discovery, those did not provide powerful rationales for political leaders to justify expensive ventures in space. International rivalry, however, did, and it sustained the program through the Apollo lunar landing program of the 1960s. R. Cargill Hall demonstrates in chapter 3 how critical this national security component was for the space program during the Eisenhower administration. As president, Eisenhower had no interest in space either for its adventure or because of the human desire to explore the unknown. He was, however, keenly interested in space as a place that could be used by the U.S. to ensure its security from surprise attack.

In chapter 4 Roger D. Launius assesses the manner in which civil space policy was made in the 1950s and early 1960s. He suggests that Eisenhower was forced by a set of political exigencies, exploited by a cadre of space enthusiasts, scientific and technical officials, and representatives of segments of the military/industrial complex, to carry out a broader space exploration effort than he desired. This cadre of interests pressed to create a civilian space agency, separate from the Department of Defense where virtually all space research was then being conducted, so they could achieve the expensive and far-reaching goals of building earth-orbiting, piloted spacecraft; a laboratory in space; human expeditions to the Moon, preceded by robots; robots to Venus and Mars; and expeditions to the nearby planets. Eisenhower held the line on aggressive space activities with the creation of NASA, but his successor in office bowed to their entreaties and empowered a scientific and technological elite with the mandate to carry out Project Apollo.

In chapter 5, Sylvia K. Kraemer, describes the detailed process of organizing resources and managing programs to carry out an expansive civilian-oriented space related effort in the United States from the creation of NASA until 1990 when the Augustine Commission issued its report on the *Future of the U.S. Space Program*. The sixth chapter, by Dwayne A. Day, deals with the often contentious story of the early history of the National Aeronautics and Space Council. Created as a result of the National Aeronautics and Space Act of 1958, the Council was intended as an interagency policy-making body to advise the president. Eisenhower's use of the Council was minimal but it was heavily involved in the review process that led to the Kennedy decision to go to the Moon and remained in existence until abolished by Richard Nixon in 1973. It was revived by

President George Bush in 1989, but its mission was folded in the Office of Science and Technology Policy by William J. Clinton when he became president in 1993. Day's study analyzes in detail the activities of the Council until it was abolished in 1973.

There are two chapters that deal specifically with military space organization also included in this book. In chapter 7 Rick W. Sturdevant describes the development of an operational capability for space activities within the U.S. Air Force. Beginning during World War II, this effort grew to large proportions by the time of the organization of a separate Air Force organization, U.S. Air Force Space Command, in 1983. Finally, Donald R. Baucom delineates the complex policy formulation processes and organizational efforts that took place in the early to mid-1980s that resulted in the creation of the Strategic Defense Initiative Office within the Department of Defense.

Whenever historians take on a project of historical analysis such as this, they stand squarely on the shoulders of earlier investigators and incur a good many intellectual debts.

The editor and authors would like to acknowledge the assistance of several individuals who aided in the preparation of this collection of essays. It was only through the assistance of several key people that we have been able to assemble the essays and put together this volume. For their many contributions in completing this project I wish especially to thank R. Cargill Hall, the AAS History Series Editor; Lee D. Saegesser, who helped track down information and correct inconsistencies; Nadine Andreasson, who helped with proofreading and compilation; Carolyn Brown, the AAS executive director; the staffs of the NASA Headquarters Library and the Scientific and Technical Information Program who provided assistance in locating materials; and archivists at various presidential libraries and the National Archives and Records Administration who aided with research efforts. In addition to these individuals, I wish to acknowledge the following scholars who aided in a variety of ways to complete this work: Virginia P. Dawson, Henry C. Dethloff, Andrew Dunar, Donald C. Elder, Linda Neumann Ezell, Adam L. Gruen, Thomas Fuller, Richard P. Hallion, Michael Q. Hooks, W. Henry Lambright, Cathleen S. Lewis, John M. Logsdon, John L. Loos, F. Mark McKiernan, John E. Naugle, A. Ingemar Skoog, Joseph N. Tatarewicz, Shirley Thomas, Stephen Waring, and Mike Wright. I also wish to thank the authors of the individual articles for their patience and helpfulness. Finally, I extend my thanks to Robert Jacobs and his associates at Univelt for their work on this book.

Roger D. Launius
Washington, D.C.

Contents

Chapter 1

A Question of Antecedents: Peenemünde, JPL, and the Launching of U.S. Rocketry

J. D. Hunley[1]

Introduction

On January 31, 1958, when the United States launched its first satellite, Explorer I, the event marked the triumph of not one but two rocket development efforts.[2] As is widely known, the Juno I launch vehicle for Explorer I was a modified Jupiter C launched by Wernher von Braun and his crew of rocket engineers from the Army Ballistic Missile Agency. It is much less well known that the second, third, and fourth stages of the Juno I consisted of 11, 3, and 1 Sergeant rockets, developed by the Jet Propulsion Laboratory (JPL) and scaled down for this mission from 31 to 6 inches in diameter. Thus, while von Braun and his engineers had designed the first stage, using a modified Redstone missile (itself derived from the V-2 developed in Germany), JPL had provided

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[1] J. D. Hunley is an historian with the National Aeronautics and Space Administration, Washington, D.C. A Ph.D. recipient from the University of Virginia, he is the author or editor of several books on German history and space exploration: *Boom and Bust: Society and Electoral Politics in the Düsseldorf Area, 1867-1878* (Garland, 1987); *The Life and Thought of Friederich Engels: A Reinterpretation* (Yale University Press, 1991); *The Birth of NASA: The Diary of T. Keith Glennan* (NASA History Series, SP-4105, 1993); and *The Problem of Space Travel: The Rocket Motor* (NASA History Series, SP-4026, 1995), a translation of Austrian engineer Hermann Noordung's 1929 study. The author wishes to thank Roger D. Launius, Michael J. Neufeld, Ernst Stuhlinger, Judith Goodstein, John Bluth, Michael H. Gorn, and Frederick I. Ordway III for helpful criticism of an earlier draft of this essay and Lee D. Saegesser plus archivists and curators at the collections cited in succeeding notes, especially John Bluth, for their assistance in locating many sources.

[2] Linda Neuman Ezell, *NASA Historical Data Book*, volume II, *Programs and Projects 1958-1968* (Washington, DC: NASA SP-4012, 1988), pp. 46-47, 235.

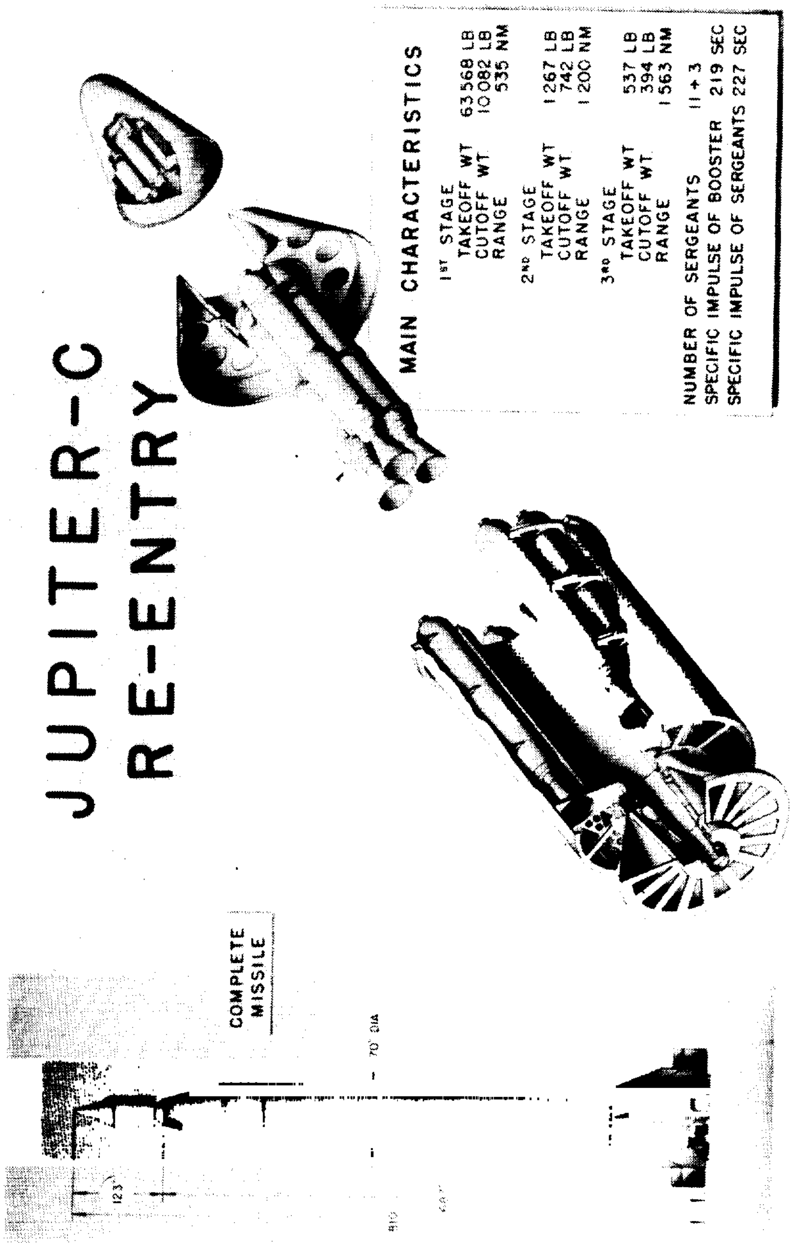

Figure 1 Jupiter-C Re-Entry Vehicle showing the clustered Sergeant rockets in the second and third stages. With the addition of a single, scaled-down Sergeant in the fourth stage, this was the same vehicle used to launch Explorer I on January 31, 1958. The event marked the triumph of rocket development efforts at von Braun's two locations in Peenemünde and Huntsville, Alabama, and at William H. Pickering's Jet Propulsion Laboratory.

the upper stages and also the satellite itself.[3] Of course, it should be added that the engineers working under von Braun also designed the guidance system for Juno and the containers for the scaled-down Sergeants, among other components.[4] The point here is not to deny proper credit to either of the two rocket teams but rather to emphasize that the credit deserves to be shared.

More importantly for the purposes of this essay, the technologies developed at Peenemünde, Germany, for the V-2 and at JPL and its predecessor organizations for a number of rocket-related projects became the bases for much of the later missile and rocket development in the United States in the ensuing decades.[5] Existing literature already makes it clear that the V-2 was in many ways the prototype for a great deal of later liquid-propellant rocketry through the Saturn V "moon rocket" and propulsion elements for the Space Shuttle, both of which were developed at the Marshall Space Flight Center, where von Braun was the director from 1960 to 1970.[6] Equally clear but less

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[3] For well-known accounts that emphasize ABMA's role and not that of JPL in the composition of the launch vehicle, see Walter A McDougall, *...the Heavens and the Earth: A Political History of the Space Age* (New York: Basic Books, Inc., 1985), p. 168; Wernher von Braun and Frederick I. Ordway III with Dave Dooling, *Space Travel: A History* (New York: Harper & Row, 1975), pp. 128, 156; and Frederick I. Ordway III and Mitchell R. Sharpe, *The Rocket Team* (New York: Crowell, 1979), pp. 380-83. For accounts that emphasize JPL's contributions to the rocket as well as the satellite, whose Geiger-Müller counter was designed by James Van Allen of the State University of Iowa, see Ezell, *NASA Historical Data Book*, vol. II, pp. 46, 235 and Clayton R. Koppes, *JPL and the American Space Program: A History of the Jet Propulsion Laboratory* (New Haven: Yale University Press, 1982), pp. 79, 86-90. Ernst Stuhlinger and Frederick I. Ordway III, *Wernher von Braun, Crusader for Space: A Biographical Memoir* (Malabar, FL: Krieger, 1994), pp. 126-37, discusses the contributions of both rocket centers in a balanced way.

[4] Donald MacKenzie, *Inventing Accuracy: A Historical Sociology of Nuclear Missile Guidance* (Cambridge, MA: MIT Press, 1990), p. 131; Fritz K. Mueller, "A History of Inertial Guidance," *Journal of the British Interplanetary Society* 38 (1985): 190; Walter Haeussermann, "Developments in the Field of Automatic Guidance and Control of Rockets," *Journal of Guidance and Control* 4 (May-June 1981): 232-33; Stuhlinger and Ordway, *von Braun*, p. 127.

[5] It should be noted that the name JPL did not come into existence until 1943 and was not formally adopted until 1944. As used here, it is thus something of an anachronism, but it serves as a convenient shorthand to avoid more cumbersome expressions such as the Guggenheim Aeronautical Laboratory, California Institute of Technology rocket and jet propulsion research projects.

[6] Besides von Braun and Ordway, *Space Travel*, among the literature that can be cited in this connection are Roger E. Bilstein, *Stages to Saturn: A Technological History of the Apollo/Saturn Launch Vehicles* (Washington, DC: NASA SP-4206, 1980), pp. 9, 12, 14, 15, 91, 195, 242, 244, 350, and 400, which also discusses the contributions to later rocketry from other sources; Wernher von Braun, "The Redstone, Jupiter, and Juno," *Technology and Culture* IV (fall 1963): 453-65 [reprinted in Eugene M. Emme, ed., *The History of Rocket Technology* (Detroit: Wayne State University Press, 1964)]; Gerhard H. R. Reisig, "Von den Peenemünder 'Aggregaten' zur amerikanischen 'Mondrakete': Die Entwicklung der Apollo-Rakete 'Saturn V' durch das Wernher-von-Braun-Team an Hand der Peenemünder Konzepte," *Astronautik* (1986): 5-9, 44-47, 73-77, 111; Konrad K. Dannenberg, "From Vahrenwald via the Moon to Dresden," as yet unpublished paper delivered at the 41st Congress of the International Astronautical Federation (IAF), Oct. 6-12, 1990, in Dresden, Germany; and the two as yet unpublished papers of Julius H. Braun, "The Legacy of HERMES," delivered at the 41st Congress of the IAF and "The Development of the JUPITER Propulsion System," delivered at the 42nd Congress of the IAF in Montreal, Oct. 5-11, 1991. Michael J. Neufeld, *The Rocket and the Reich: Peenemünde and the Coming of the Ballistic Missile Era* (New York: The Free Press, 1995), p. 279, also supports this view but goes too far when he calls the V-2 "the grandfather of all modern guided missiles and space boosters."

well-known is the contribution made by JPL scientists and engineers during and immediately after the war to technological developments culminating in later U.S. solid-propellant missiles and rockets from the Polaris and Minuteman to the solid rocket boosters on the Space Shuttle.[7]

In view of this influence on later developments, it is important for historians of rocketry to understand how managers at Peenemünde and at JPL organized their resources to achieve innovations in rocket technology. What is significant here is not any similarity or dissimilarity between the formal ways in which the two organizations appeared on schematic diagrams, which changed over time in any event. Instead, the account that follows will discuss the ways in which Peenemünde and JPL integrated contributions from theory, from individuals within each organization, and from outside organizations to generate new technologies. Specifically, this essay will argue that despite significant differences in the scale of operations at Peenemünde and JPL and despite differences in personalities and national cultures, the procedures used by scientists and engineers in both locations were in many ways analogous. Both relied to a significant degree upon expertise and technology from outside in achieving innovations, although both also did the bulk of the development in-house. Both employed an early form of what later came to be called systems engineering, which can be defined as integrating the components of a system (in this case, a missile or rocket) together and supervising their testing so as to ensure that the system fulfills its objectives.[8] Both relied heavily

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[7] See Theodore von Kármán with Lee Edson, *The Wind and Beyond* (Boston: Little, Brown and Co., 1967), pp. 244-46; Koppes, *JPL*, pp. 1-24 (esp. p. 12), 36-38, 62-79; P. Thomas Caroll, "Historical Origins of the Sergeant Missile Powerplant," in Kristan R. Lattu, ed., *History of Rocketry and Astronautics*, AAS History Series, vol. 8 (San Diego: Univelt, Inc., 1989), pp. 121-46, esp. 125, 143; Karl Klager and Albert O. Dekker, "Early Solid Composite Rockets," unpublished paper completed Oct. 1972, p. 3, available in the NASA Historical Reference Collection; Karl Klager, "Historical Breakthroughs and their effect on Solid Rocket Performance," unpublished paper delivered at the American Institute of Aeronautics and Astronautics meeting in Monterey, July 10-14, 1989, unpaginated. I am grateful to Dr. Klager for generously sending me copies of these and other papers. He was instrumental in the further development of solid propellant rocketry at Aerojet-General Corporation, including the polyurethane solid propellant used in Polaris. In the two papers cited above, he and his co-author note that the development of asphalt as a binder and potassium perchlorate as oxidizer at JPL during the war "represented the principal breakthrough on which today's sophisticated solid composite propellants are based" (p. 3 of "Early Solid Composite Rockets"), noting that this discovery raised the specific impulse of solid rockets from 86 to about 180 seconds (more than 100 percent), whereas the important later addition of aluminum powder to the propellant, discovered by the Atlantic Research Corporation, raised specific impulse only a nevertheless critical 15 percent further (cf. "Historical Breakthroughs" with another of his papers, "Early Polaris and Minuteman Rocket Motor History," undated [c. 1980], p. 3). Klager also points to the many other developments that have played a role in the subsequent history of solid rocketry, which was not as simple as these quotations would suggest. On the linkage between JPL and the solid rocket boosters for the Shuttle, see Braun, "Legacy of Hermes," no pagination.

[8] Derived from a more complicated definition in Harvey M. Sapolsky, *The Polaris System Development: Bureaucratic and Programmatic Success in Government* (Cambridge, MA: Harvard University Press, 1971), p. 86, quoting a contract with the Air Force by the Aerospace Corporation. See Sapolsky's discussion of the concept on pp. 79-89, 137-38.

upon theory to guide the development effort and suggest what could and could not be done. Finally, if less significantly perhaps, in both rocket development programs, production came to be done at a separate location from the development center—at the infamous underground site named Mittelwerk (central factory) operated by the Armaments Ministry and the SS in the case of the V-2 and by the Aerojet Engineering Corporation in the case of the propulsion technologies developed during the war at JPL and the Guggenheim Aeronautical Laboratory of the California Institute of Technology (GALCIT) rocket research project that preceded it.

Peenemünde

Although there were earlier relevant rocket development efforts by private groups,[9] for purposes of this essay the beginnings of German liquid-propellant rocket development leading to the V-2 can be dated to late 1932 when von Braun began working at the Kummersdorf Army Proving Grounds, south of Berlin, for Army Ordnance.[10] Von Braun was son of a landowner and former chief magistrate of a governmental district who became the minister of nutrition and agriculture in the last two governments of the Weimar Republic. In 1932 the 20-year-old had completed five semesters of instruction at the Technical Institutes of Berlin and Zurich in mechanical and aeronautical engineering and was working on his doctorate in physics at the University of Berlin. He received his Ph.D. in 1934 for a dissertation describing rocket propulsion and ballistics.[11] As he later reported, von Braun began work at Kummersdorf with a staff of one mechanic and a laboratory consisting of "one half of a concrete pit covered by a sliding roof," the other half being "devoted to powder rockets."[12]

[9] There are lots of relevant sources for their history, but good discussions appear in Neufeld, *Rocket and the Reich*, pp. 9-22, and Frank H. Winter, *Prelude to the Space Age: The Rocket Societies* (Washington, DC: Smithsonian Institution Press, 1983), pp. 38-44.

[10] See Neufeld, *Rocket and the Reich*, p. 295n39 for a discussion of the precise date, which von Braun lists as November 1, 1932, in his "Reminiscences of German Rocketry," *Journal of the British Interplanetary Society* 15 (May-June 1956): 131. Two valuable unedited versions of this essay with somewhat fuller information on some matters are available at the U.S. Space and Rocket Center in Huntsville, AL, in folders marked "Behind the Scenes of Rocket Development in Germany, 1928-1935" and "The Development of German Rocketry Prior to 1945." I am grateful to James Hagler, Curator of Exhibits and Artifacts, for allowing me to use this collection.

[11] Stuhlinger and Ordway, *von Braun*, pp. 9-11; Erik Bergaus, *Wernher von Braun* (Washington, DC: National Space Institute, 1976), pp. 34, 44; Military Personnel Service, Basic Personnel Record, Wernher von Braun, [1946], copy in file 005018 on von Braun's SS and Nazi Party Membership, NASA Historical Reference Collection, Washington, DC; Wernher von Braun, "Konstruktive, theoretische und experimentelle Beiträge zu dem Problem der Flüssigkeitsrakete," (PhD Dissertation, University of Berlin, April 16, 1934), copy in folder 002558, von Braun, Dissertation, NASA Historical Reference Collection.

[12] von Braun, "Reminiscences of German Rocketry," p. 131.

The staff reporting to von Braun grew substantially in the coming years, especially after 1937 when most of the development work moved from the cramped quarters at Kummersdorf to Peenemünde on the Baltic coast, but the numbers involved in developing the series of rockets (A-1, A-2, A-3, and A-5) that led up to the V-2 (or A-4, to use its developmental designation) is unclear because of the involvement of many individuals on other projects like assisted take-off for Luftwaffe aircraft and anti-aircraft missiles like Wasserfall (Waterfall). Michael Neufeld, for example, reports from his extensive archival research that Peenemünde opened in May 1937 with 349 employees of which 123 were white collar; that there were about 1,200 employees in September 1939 and some 12,000 workers at the peak of activities in 1943; and that the numbers shrank to 7,278 in November 1943 and 4,863 Germans in August of 1944—a number that dropped further to 4,325 at the beginning of 1945. Only the last figure is broken down by project: 135 assigned to the Taifun anti-aircraft missile, 1,220 to Wasserfall, and 1,940 to the A-4 plus 270 on the winged A-4b and 760 as supply or administrative personnel.[13] The last breakdown and the fact that only about half of the peak figure was engaged in development efforts suggest that some rough figures compiled by the former Peenemünde managers Eberhard Rees and Arthur Rudolph after the war may give a roughly accurate if incomplete and conservative picture of those employed exclusively in the development of the A-5 test missile and then the A-4 itself:[14]

1937 - 250	1939 - 700	1941 - 1,500	1943 - 3,000
1938 - 400	1940 - 1,000	1942 - 2,000	1944 - 3,000

One of the services of Neufeld's book on Peenemünde has been to provide a detailed but not overly technical discussion of the technologies involved in the development of the A-4. There is not room here for more than an overview of his findings, but basically he saw the keys to the successful evolution of the A-4 as being the "everything-under-one-roof" approach of von Braun's military superior, Walter Dornberger; the excellent management of von Braun and Dornberger, including their fostering of internal communication and their successful advocacy of the program with officials in the German army and the Nazi state; and the development by "highly talented engineers" in a "lavishly funded and staffed organization" of three key technologies: "large liquid-fuel rocket engines, supersonic aerodynamics, and guidance and control."

[13] Neufeld, *Rocket and the Reich*, pp. 55, 74, 206, 243, 248, 255; Ernst Klee and Otto Merk, *The Birth of the Missile: The Secrets of Peenemünde* (London: Harrap & Co., 1965), p. 109, which gives figures for early 1945 that are included in the narrative since Neufeld's almost identical figures on p. 255 do not add up to his total on p. 248.

[14] Rees and Rudolph, "Short Report about the Time for Development and Manufacturing of the A4 Rocket in Germany," from the folder, "A4 Missile" in the von Braun Collection at the U.S. Space and Rocket Center. These figures exclude military personnel, the general maintenance crew, power plant personnel, the plant railroad and ship crews, motor pool personnel, etc. Thus they provide a very conservative estimate.

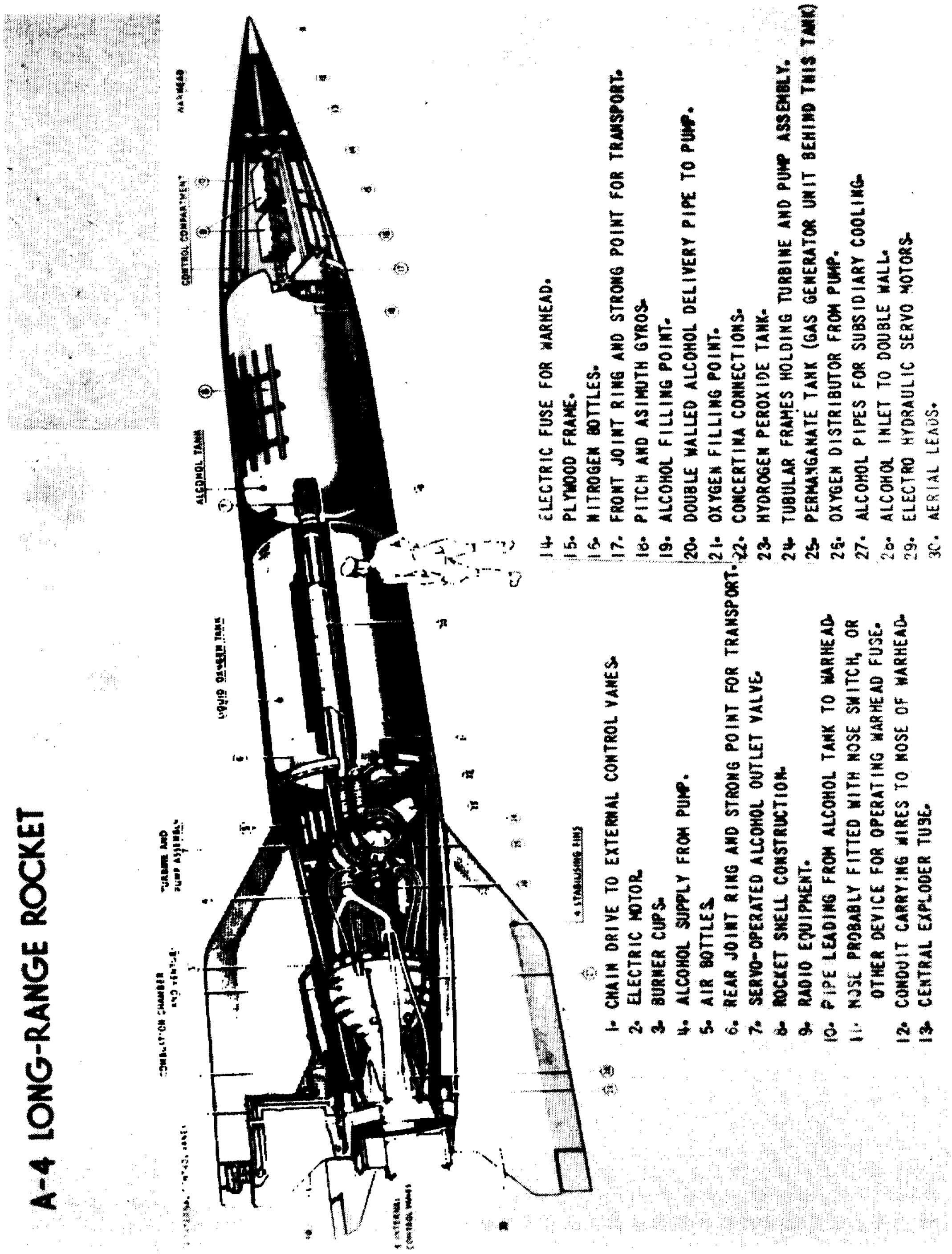

Figure 2 Schematic of the A-4 showing many of the technologies involved in its operation.

In the area of propulsion, Neufeld argues that Walter Thiel, a chemical engineer with "keen theoretical insight," developed an improved injection system coupled with an 18-pot "pre-chamber system," a shortened combustion chamber compared with earlier models developed at Kummersdorf, plus a shorter and wider nozzle to improve the efficiency of combustion. His co-worker Moritz Pöhlmann's suggestion of film cooling within the combustion chamber coupled with the use of external regenerative cooling ultimately solved the problem of burnthroughs from the heat of combustion, while technology from Helmuth Walter's firm at Kiel (in its work with hydrogen peroxide for the Navy) furnished the turbopumps to feed the liquid propellants (alcohol and liquid oxygen) from their tanks into the chamber. This, says Neufeld, was the only important contribution to the propulsion system from outside corporations, although he does also point to "significant suggestions" by a Professor Wewerka of the Technical Institute at Stuttgart for overcoming turbopump design problems and Wewerka's confirmation of Thiel's findings about the optimal angle for the exhaust nozzle.[15]

If the perspective on the development of technology is not simply what contributed solely to production models of the V-2 but the longer-range contributions of Peenemünde to (especially) American missiles and rockets, the emphasis on in-house contributions in Neufeld's account lessens in significance. It is clear that there were other important contributions from technical institutes, especially those of Professor Karl Wagner and his associates at Darmstadt. In a report dated March 29, 1941, Thiel and one of his associates, the chemist Gerhard Heller, wrote that building upon the work of Wagner at Darmstadt and Wewerka at Stuttgart together with the theoretical bases and experimental work done at Kummersdorf and Peenemünde, they had developed a comprehensive foundation for the redesign of the combustion chamber for the A-4. Wagner and his associates had been commissioned in 1939, at the so-called "Day of Wisdom" at Peenemünde (when a number of scientists and engineers from technical institutes and universities were brought there for a conference at the end of September) to calculate exit velocities and thrusts at different pressures for the burning of the propellants used in the A-4. They had done this in a series of reports beginning in December 1939, and Thiel evidently had found their work very useful, along with that of Wewerka, in redesigning his propulsion system.[16]

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[15] Neufeld, *Rocket and the Reich*, pp. 73-85.

[16] Dr. Ing. Thiel and Dipl. Chem. Heller, "Grundlagen für die Neukonstruktion von Öfen und Ermittelung von Versuchsdaten," Heeres-Versuchstelle Peenemünde (HVP) Archiv Nr. 52/2, in Tschinkel Papers, U.S. Space and Rocket Center, pp. 5, 85-86; Prof. Dr. Karl Wagner and co-workers, "Bericht über die thermodynamische Durchdringung des Zustandes von Feuerungsgasen . . .," HVP Archiv Report 20/1g, PGM microfilm, roll 9, National Air and Space Museum Archive in Silver Hill, MD, and subsequent reports in the 20/ series on rolls 9 and 10, esp. Archive Report 20/15, which begins (p. 2) with a summary of previous reports; Aktennotiz über die Einführungsbesprechung: "Mitarbeit von Hochschul-Instituten, Vorhaben Peenemünde," am 28.9.39 auf Versuchsplatz Kummersdorf, Versuchsstelle West, Oct. 4, 1939 in box marked Peenemünde Document Collection, File 2 at the National Air and Space Museum Archives in Washington, DC; "Interrogation of Professor Dr. Carl Wagner, Kitzingen, 20 April '45," Peenemunde [sic] East Through the eyes of 500 detained at Garmish, p. 100, seen in the NASA Historical Reference Collection, Folder 002685. For different perspectives on the "Day of Wisdom" see Neufeld, *Rocket and the Reich*, p. 83, and Ordway and Sharpe, *Rocket Team*, p. 35.

Figure 3 Cut-away schematic of the A-4 combustion chamber showing the arrangement of the 18-pot injection system as well as the regenerative cooling devices.

Besides Wewerka and Wagner, Thiel's deputy and then successor as head of the propulsion unit at Peenemünde, Martin Schilling, pointed to Prof. Hase of the Technical Institute of Hannover and Prof. Richard Vieweg of the Technical Institute of Darmstadt as contributing "largely to the field of powerplant instrumentation." Other "essential contributions" that Schilling listed included those of Prof. Schiller of the University of Leipzig in investigating the field of regenerative cooling, and Professors Pauer and Beck at the Technical Institute of Dresden "for clarification of atomization processes and the experimental investigation of exhaust gases and combustion efficiency, respectively."[17] In an immediate post-war interview at Garmish-Partenkirchen, an engineer named Hans Lindenberg who had been doing research on fuel injectors for diesel engines at the Technical Institute of Dresden from 1930 onwards and from 1940 on, partly at Dresden and partly at Peenemünde, on the combustion chamber of the A-4, even claimed that the design of the A-4's fuel injection nozzles "was settled at Dresden." This was undoubtedly an exaggeration, but he added that Dresden had a laboratory for "measuring the output and photographing the spray of the alcohol jets," and unquestionably Dresden and other technical institutes contributed ideas and technical data that were important in the design of the propulsion system.[18] Along similar lines, Konrad Dannenberg, who worked on the combustion chamber and ignition system at Peenemünde from mid-1940 on, described their development in general terms and then added, "Not only Army employees of many departments participated, but much of this work was supported by universities and contractors, who all participated in the tests and their evaluation. They were always given a strong voice in final decisions."[19]

An analogous picture of outside contributions to a development process that centered at Peenemünde emerges from an examination of supersonic aerodynamics for the A-4 and its predecessor missiles. Again, Neufeld provides a clear discussion of the basic picture. He describes the rise of aerodynamics "under the direction of . . . Ludwig Prandtl of Göttingen" and discusses von Braun's contacts with Dr. Rudolf Hermann at the Technical Institute of Aachen. Hermann tested the A-3 design in a small supersonic wind tunnel he had helped build at Aachen, resulting in an enlargement of the rocket's fins to make it more stable in flight but far from ideal in its design. Since access to Aachen's small supersonic tunnel was limited, von Braun and Dornberger induced Hermann to join their staff at Peenemünde in April 1937 and to construct a much larger supersonic wind tunnel with a higher maximum speed (Mach 4.4). Since the new tunnel was not available for several years, Hermann and his assistant Dr. Hermann Kurzweg

[17] Martin Schilling, "The Development of the V-2 Rocket Engine," Th. Benecke and A. W. Quick, eds., *History of German Guided Missiles Development* (Brunswick, Germany: E. Appelhans & Co, 1957), pp. 284-85. Schilling, like many other authors, does not list scientists and engineers' first names. Where they have been available, I have added them here and elsewhere in this essay.

[18] "Peenemünde East Through the eyes of 500," pp. 184-185. Cf. the interview Michael Neufeld conducted with Konrad K. Dannenberg, Nov. 7, 1989, pp. 14-32, transcript available at the National Air and Space Museum. I am grateful to Dr. Neufeld and Jo Ann Bailey for making these interviews available to me and for Neufeld's and the Air and Space Museum's arranging for me to have privileges as a researcher in the Smithsonian Institution.

[19] Dannenberg, "Vahrenwald via the Moon," p. 3.

had to improvise in designing the A-5 and A-4 as well as to rely upon wind tunnel testing at Aachen and a subsonic tunnel of the Zeppelin Airship Construction Company in Friedrichshafen. Then the shape of the A-4 was refined based on wind tunnel tests at Zeppelin and Peenemünde once the new supersonic tunnel was ready in 1940. Neufeld points to the contributions of Dr. Max Schirmer at Zeppelin in particular for the "refinement of the rocket's design and the elimination of uncertainties in many areas," but he concludes that Schirmer's contributions were "still modest" and that those of academic research "after the start of the war were less important."[20] Nevertheless, his account makes it clear that Aachen made important contributions before Hermann moved to Peenemünde and that academic and corporate involvement continued after that.

As was true with propulsion, so in aerodynamics it is possible to add to and refine Neufeld's treatment in order to reach a fuller understanding of the process of innovation at Peenemünde in its long-range perspective. Again, as with propulsion, outside influences seem slightly more important than is evident in Neufeld's account. In his own discussion of the A-4's aerodynamic development, Hermann Kurzweg emphasized the extent to which he and his colleagues relied on the theoretical work of Prandtl and other aerodynamicists, including Adolf Busemann—the German who in 1935 introduced the idea of swept wings to reduce drag at supersonic speeds and who came to the United States after World War II—and Theodore von Kármán, who founded an Aeronautical Institute at Aachen before World War I and later moved to the California Institute of Technology (Caltech) where he founded the JPL. Kurzweg noted, for example, that an article von Kármán coauthored on "Resistance of Slender Bodies" in 1932 became the basis of calculation on the pressure distribution of the A-5 and A-4. In addition, Kurzweg pointed out that during the war W. Tollmien of Dresden and R. Sauer of Aachen "developed their methods of characteristics for axisymmetric bodies and calculated for us the pressure distribution over the A-4 bare bodies."[21]

In the third area of important innovation, guidance and control, there is fortunately no need to go into details. Von Braun created Ernst Steinhoff's guidance and control division later than the comparable shops for propulsion and aerodynamics, and its problems were severe. Consequently, at least three different firms—Kreiselgeräte GmbH, Siemens, and Askania—competed to provide a control system, and "research in guidance and control occupied more university personnel than the other two key technologies combined," according to Neufeld. Neufeld also points out that "university institutes, particularly in Berlin and Dresden, made many contributions to the work. Of particular importance was the tracking system developed by Professor Wolman of Dresden."[22] The

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[20] Neufeld, *Rocket and the Reich*, pp. 85-94.

[21] Hermann H. Kurzweg, "The Aerodynamic Development of the V-2," Benecke and Quick, eds., *German Guided Missiles*, p. 53. On von Kármán, the reader can consult the readable biography by Michael H. Gorn, *The Universal Man: Theodore von Kármán's Life in Aeronautics* (Washington, DC: Smithsonian Institution Press, 1992). I am not aware of a comparable source on Busemann, but some information is available in James R. Hansen, *Engineer in Charge: A History of the Langley Aeronautical Laboratory, 1917-1958* (Washington, DC: NASA SP-4305, 1987), pp. xxxiv, 282-83, 334-36.

[22] Neufeld, *Rocket and the Reich*, pp. 94-107, esp. pp. 102-3.

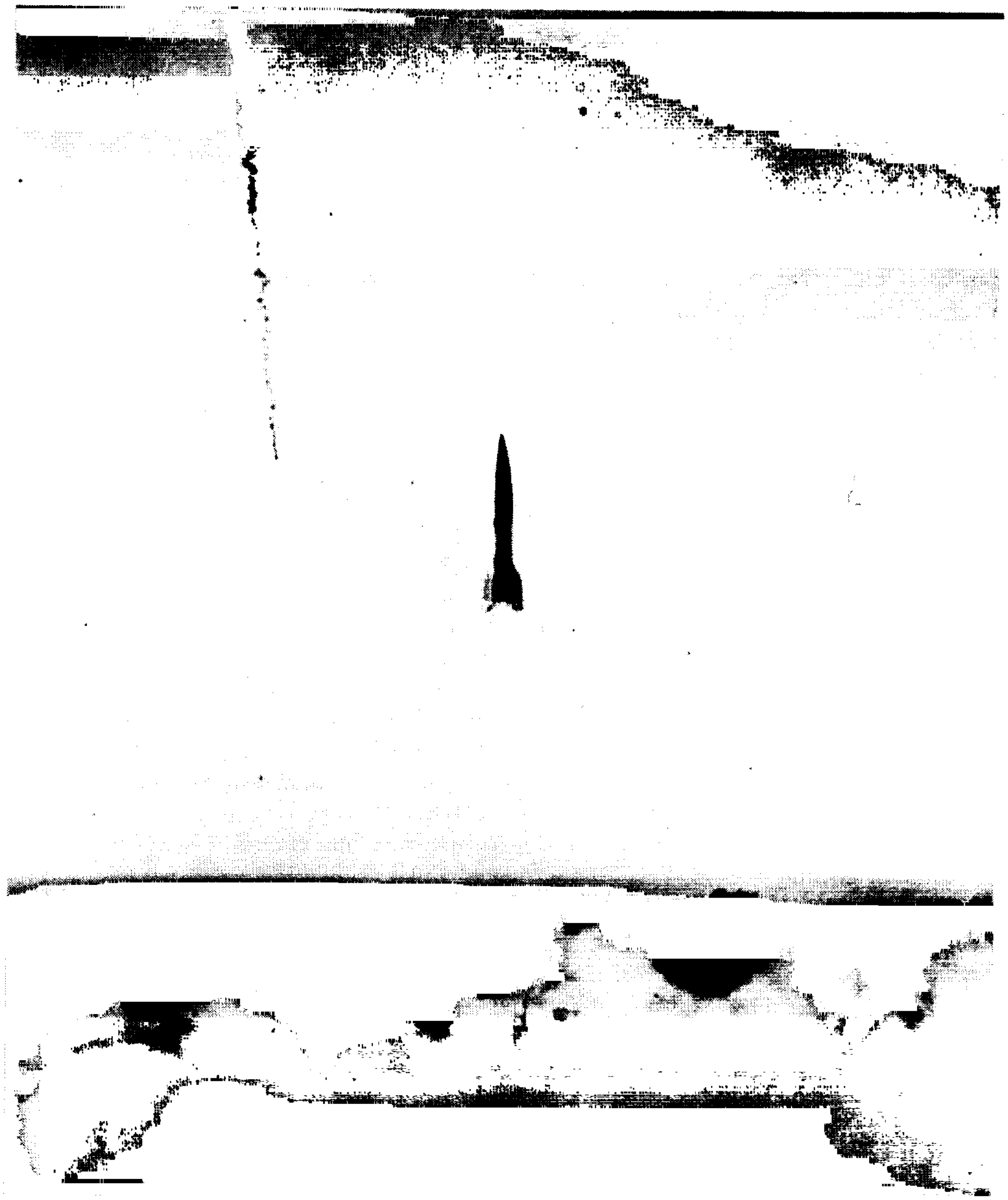

Figure 4 A-4 missile after launch.

resultant very complex combination of guidance and control devices used on the A-4 consisted of contributions from a variety of sources, including those working at Peenemünde itself.[23]

In the process whereby these three key technologies were developed and integrated together to constitute a functioning missile system, there were numerous factors at work. As is evident from what has already been said and as other sources attest, the use of available theory was important, although there were limits to its applicability in the development of new technologies. Consequently, empirical research both at Peenemünde and at contributing academic institutions and commercial firms also made important contributions. In addition, discussions between individuals working on related problems both at Peenemünde and at academic institutions helped lead to solutions to individual problems.[24] In this connection, the leadership of Wernher von Braun and others was very important. Walter Haeussermann, who worked on guidance and control at both Peenemünde and at the Technical Institute of Darmstadt, has commented about von Braun's fostering of communication between different departments as well as within a single department.[25] This sort of informal communication was supplemented by meetings of technical personnel to resolve particular issues, by personal contacts between von Braun and individual engineers or scientists, and by more general meetings perceptively and incisively led by von Braun. According to Dieter Huzel, who held a variety of positions at Peenemünde in the last two years of the war, von Braun "knew most problems at first hand. . . . He repeatedly demonstrated his ability to go coherently and directly to the core of a problem or situation, and usually when he got there and it was

[23] Besides Neufeld, these comments are based on MacKenzie, *Inventing Accuracy*, pp. 50-60; Haeussermann, "Guidance and Control of Rockets," pp. 226-232; Mueller, "History of Inertial Guidance," pp. 181-85; Otto Müller, "The Control System of the V-2," Bennecke and Quick, eds., *German Guided Missiles*, pp. 80-101; James E. Tomayko, "Helmut Hoelzer's Fully Electronic Analog Computer," *Annals of the History of Computing* 7 (July 1985): 229-36; interview, author with Ernst Stuhlinger, Sept. 20, 1994, pp. 1-27, transcript in the NASA Historical Reference Collection.

[24] See, e.g., Neufeld's interview with Walter Haeussermann, Jan. 24, 1990, transcript at the National Air and Space Museum, pp. 25-27, 36-38; his interview with Arthur Rudolph, Aug. 4, 1989, pp. 59-60, which discusses the role of the firm Klein, Schanzlin and Becker in the development of an oxygen pump for the A-4; Klee and Merk, *Birth of the Missile*, p. 20, which reproduces a document from 1935 also indicating the involvement of that firm in the development of the turbopump for propellants; Krafft A. Ehrike, "The Peenemünde Rocket Center, Part 3," *Rocketscience* 4 (September 1950): 60-62 and "Part 4," (December 1950): 81, indicating that Klein, Schanzlin and Becker were not successful in developing the turbopumps and that development transferred to Peenemünde but also commenting on other outside contributions; my own interview with Ernst Stuhlinger, p. 24; J.S. Farrior, "Inertial Guidance, Its Evolution and Future Potential," in Ernst Stuhlinger et al., eds, *From Peenemünde to Outer Space* (Huntsville, AL: Marshall Space Flight Center, 1962), pp. 402-3.

[25] Neufeld's interview with Haeussermann, pp. 45-47.

clarified to all present, he had the solution already in mind—a solution that almost invariably received the wholehearted support of those present."[26]

Relatedly, Walter Dornberger has described how as "a good systems engineer, he [von Braun] knew how things should and must fit together[;] he not only coordinated but also directed the widespread effort of the many branches of research, engineering, manufacturing and testing in Peenemünde."[27] This analysis, of course, is written in retrospect and uses the term "systems engineering," which arose only after the war. But it squares with other portraits of von Braun's role. Unquestionably, there were continual problems to which there were no easy solutions; unquestionably von Braun made some mistakes; and undoubtedly the large resources at Peenemünde contributed to the development effort. But the key to the development of technology at Peenemünde seems to lie in the synergy of efforts both inside and outside of the rocket center and their creative blending into a workable system. For this, not only von Braun but Dornberger, Thiel, Hermann, Steinhoff, and other managers were responsible.[28]

The Jet Propulsion Laboratory

It is difficult to compare processes at Peenemünde with those at the rocket research project at what became JPL (in 1944) because of the differences in resources available to the two organizations. Another complication lies in the complexity and multi-disciplinarity of work on ballistic missiles. In May of 1945, Dr. Homer E. Newell, who was then working as a theoretical physicist and mathematician at the U.S. Naval Research Laboratory and later became associate administrator for space science and applications in the National Aeronautics and Space Administration, wrote that the "design, construction, and operational use of guided missiles requires intimate knowledge of a vast number of subjects. Among these . . . are aerodynamics, kinematics, mechanics, elasticity, radio, electronics, jet propulsion, and the chemistry of fuels."[29] It is obviously impossible in brief compass to compare the resources available to the managers at Peenemünde with their extensive assistance from industry and the academic community

[26] Dieter K. Huzel, *Peenemünde to Canaveral* (Englewood Cliffs, NJ: Prentice-Hall, Inc., 1962), p. 126. See also the numerous reports of meetings scattered throughout the documents that survive from Peenemünde and Kummersdorf; e.g. Niederschrift Nr. 401/37, 6/8-9/9/37 in FE 74b, Roll 6 of microfilm at the Air and Space Museum's archive at Silver Hill and Niederschrift über die Besprechung am 23.4.42 in, Folder 3 of the Peenemünde Document Collection at the Air and Space Museum in Washington, DC.

[27] Walter R. Dornberger, "Epilogue," *Peenemüunde to Outer Space*, p. 852.

[28] There are no specific page references that I can give for these judgements, but see all of the interviews cited above, Huzel's *Peenemünde to Canaveral*, and Dornberger's *V-2*, trans. by James Cleugh and Geoffrey Halliday (New York: Viking, 1958) as well as the first part of Stuhlinger and Ordway, *von Braun: A Biographical Memoir*.

[29] Homer E.; Newell, Jr., "Guided Missile Kinematics" (Naval Research Laboratory, May 22, 1945), p. 1, seen in the National Archives (NA), Record Group (RG) 218, Joint New Weapons Committee (JNWC), Subj. File May 1942-1945.

in Germany, on the one hand, with those available to JPL, on the other, across so many disciplines. To the extent that theoretical physics was a factor, it seems clear that the United States in general lagged behind Germany early in the century but had caught up and perhaps surpassed Germany by the late 1920s or early 1930s.[30]

In the application of scientific theory to engineering, however, it appears that the U.S. lagged significantly behind Germany until after World War II, although there were exceptions in some fields, and educational institutions and European engineers had begun in the 1920s and 1930s to demonstrate the importance of scientific theory to American engineers. The U.S. was slow in changing, though, and remained committed to a much more practical, non-theoretical approach than prevailed in Germany.[31] This was notably true in the vital discipline of aerodynamics, which was especially critical for the development of ballistic missiles.[32] In Germany, on the other hand, the mathematician Felix Klein had established a strong tradition at the University of Göttingen around the turn of the century of applying scientific theory to engineering, and strong centers of theoretical aerodynamics had developed especially at Göttingen and the Technical Institute of Aachen by the beginning of World War I. As already seen, Hermann had come from Aachen to Peenemünde. He had close ties with the leading aerodynamicists in Germany and had reports done for Peenemünde by aerodynamicists at Göttingen, among other places.[33]

Fortunately for the development of rocketry at JPL, however, by 1930 Robert A. Millikan and his associates at what had been Throop College of Technology had not only succeeded in converting that institution into the elite research university known after 1920 as Caltech; they had also lured a major theoretical aerodynamicist, Theodore von Kármán, from Aachen to become the director of the Guggenheim Aeronautical

[30] See, e.g., Gerald Holton, "On the Hesitant Rise of Quantum Physics Research in the United States," in Stanley Goldberg and Roger H. Stuwer, eds., *The Michelson Era in American Science, 1870-1930* (New York: American Institute of Physics, 1988), pp. 181-82, 194n3; Mark Walker, *German National Socialism and the Quest for Nuclear Power, 1939-1949* (Cambridge: Cambridge University Press, 1989), esp. 74-75; David C. Cassidy, *Uncertainty: The Life and Science of Werner Heisenberg* (New York: W. H. Freeman and Co., 1991), esp pp. 262-63; and Spencer R. Weart, "The Physics Business in America, 1919-1940: A Statistical Reconnaissance," in Nathan Reingold, ed., *The Sciences in the American Context: New Perspectives* (Washington, DC: Smithsonian Institution Press, 1979), pp. 298-99, 309.

[31] Bruce Seely, "Research, Engineering, and Science in American Engineering Colleges: 1900-1960," *Technology and Culture* 34 (April 1993): 344-67.

[32] See, e.g., Hansen, *Engineer in Charge*, p. xxxiv; Paul A. Hanle, *Bringing Aerodynamics to America* (Cambridge, MA: MIT Press, 1982), pp. xi, 14.

[33] On Klein and Göttingen, Hanle, *Bringing Aerodynamics*, pp. 22-27, 66-67; on Aachen, Hanle and "Comparative History of Research and Development Policies Affecting Air Materiel, 1915-1944," prepared for the Scientific Advisory Group, Office of the Chief of Air Staff by Historical Division, Assistant Chief of Air Staff, Intelligence, June 1945, pp. 136-137, seen in NA, RG 18 (Army Air Forces), Air Adjutant General, Bulky Decimal File 353.41-360.2; on the reports done for Peenemünde by the University of Göttingen, Peenemünde Archives Reports 41/9, 41/12, 41/13-41/15 available at the Scientific Information Center at Redstone Arsenal; on Hermann's connections to other aerodynamicists, interview, Sandy Sherman with Hermann, Apr. 22-Jul. 2, 1988, transcript in National Air and Space Museum archives, folder CH-335500-01, Rudolf Hermann, esp. pp. 12-16.

Laboratory at Caltech. There he trained a generation of engineers in theoretical aerodynamics and fluid dynamics.[34] Von Kármán's importance is suggested by a remark of Allen J. Puckett: "There had been a school of thought—and I'm afraid MIT was part of this—that engineering was a sort of trade. You learned how to calculate things by reading equations out of a handbook. It was von Kármán who changed all that by introducing the whole concept of using fundamental theory and precise analysis, by relying on basic principles, to arrive at your result."[35] More generally, with its eminence in physics, physical chemistry, and astrophysics as well as aeronautics,[36] Caltech proved to be an almost ideal site for the early development of U.S. ballistic rocketry, one that allowed it to rival the achievements of the much larger center at Peenemünde despite the latter's more lavish funding and earlier start. Of course, Robert H. Goddard, the brilliant if eccentric rocket pioneer from Clark University in Massachusetts, had begun developing rockets even earlier, but his inability to cooperate meaningfully with others and his faulty systems engineering practices limited his influence and overall successes. (He did succeed in developing many innovative components for his rockets, but he never combined them in a rocket that rose to the altitudes he sought.)[37]

Despite von Kármán's presence and the work being done at Caltech in aerodynamics, it would appear that but for a chance confluence of circumstances, the university would not have gotten involved in research on surface-to-surface ballistic missiles. In Germany, Army ordnance's interest in the subject dated back to the early 1930s. At Caltech, according to then-graduate student Frank J. Malina, the start of rocket development occurred in 1936 when William Bollay, another of von Kármán's graduate students, gave a presentation on the prospect of rocket-powered aircraft, based primarily on the work of Eugen Sänger, a Viennese engineer who, while employed at the Technical Institute of Vienna from 1933-1935, had studied liquid-propellant combustion chambers for rockets.[38] A newspaper report of Bollay's lecture attracted two rocket enthusiasts to GALCIT—Edward S. Forman and John W. Parsons, described respectively by Malina as "a skilled mechanic" and "a self-trained chemist" without formal schooling but with "an

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[34] Seeley, "Research, Engineering, and Science," p. 363; Hanle, *Bringing Aerodynamics*, pp. 80-157; Judith R. Goodstein, *Millikan's School: A History of California Institute of Technology* (New York: W.W. Norton, 1991), esp. pp. 74-75, 163-64; Gorn, *Universal Man*, pp. 49-92. On the rise of Caltech "as a major center of American science," see also Roger L. Geiger, *To Advance Knowledge: The Growth of American Research Universities, 1900-1940* (Oxford: Oxford University Press, 1986), pp. 183-91. On von Kármán's students, see also Shirley Thomas, "Theodore von Kármán's Caltech Students," paper presented at the 43rd IAF Congress, 28 Aug.-5 Sept. 1992 in Washington, DC.

[35] Thomas, "von Kármán's Caltech Students," p. 13.

[36] Geiger, *Growth of American Research Universities*, p. 188.

[37] See my "The Enigma of Robert H. Goddard," *Technology and Culture* 36 (Apr. 1995): 327-350.

[38] On Sänger, see Irene Sänger-Bredt, "The Silver Bird Story: A Memoir," R. Cargill Hall, ed., *Essays on the History of Rocketry and Astronautics: Proceedings of the Third Through the Sixth History Symposia of the International Academy of Astronautics*, AAS History Series, Vol. 7, Part I (San Diego: Univelt, 1986), pp. 195-228. Like von Braun, Sänger was inspired to work on rockets by science fiction and the early writings of Hermann Oberth. Sänger did not work at Peenemünde, however.

uninhibited fruitful imagination." Together, they teamed up with Malina, a graduate of Texas Agricultural and Mechanical University in mechanical engineering who had earned an M.S. in mechanical engineering at Caltech in 1935 and was then completing an M.S. in aeronautical engineering there as well.[39] Apparently, Parsons did actually take some chemistry courses from the University of Southern California in 1935-1936, although he never graduated, and he worked as a chemist for Hercules Powder Company in Los Angeles from 1932 to 1934 and then was chief chemist for Halifax Explosives Company in Saugus, California, from 1934-1938.[40] Malina, whose family was of Czech descent, himself became interested in rocketry when he, like many another rocket enthusiast, read Jules Verne—only in his case he read it in Czech at the age of 12.[41] He revealed in an interview in 1973 that Parsons had a fascination with magic that Malina, as a rationalist, found suspect.[42]

Although they constituted a rather surprising partnership, these three individuals agreed to work together at the suggestion of Bollay, who was occupied with other efforts, and in March 1936 von Kármán agreed that Malina could do his doctoral dissertation on rocket propulsion and rocket flight with the assistance of Parsons and Forman, "even though they were neither students nor on the staff at Caltech."[43] Given von Kármán's background, his agreement was not surprising, but unlike the German army, the U.S. military displayed no early interest in surface-to-surface rockets.[44] It did support an

[39] Frank J. Malina, "The Jet Propulsion Laboratory: Its Origins and First Decade of Work," *Spaceflight* 6 (1964): 160-161. This article appeared in two parts (5 & 6), pp. 160-165 and 216-223. See also "Biographical Information" compiled by Malina on May 1, 1968, and available in folder 001418, Malina, Frank J., in the NASA Historical Reference Collection.

[40] Frank H. Winter and George S. James, "Highlights of 50 Years of Aerojet, A Pioneering American Rocket Company, 1942-1992," *Acta Astronautica* 35 (May-June 1995): 698 n. 1. I am grateful to John Bluth of the JPL Archives for calling my attention to this citation and to the FBI file on Parsons, No. 65-59589, p. 8, which gives the dates and locations shown in the narrative that differ slightly from those in Winter and James' note. According to the FBI file, relying on Parsons' own testimony, he took only correspondence and extension courses from the University of Southern California and also the University of California. Presumably the latter were also in chemistry, although the file does not state this.

[41] Interview of Malina by R. Cargill Hall, Oct. 29, 1968, p. 1, transcript at the JPL Archives in Pasadena, CA.

[42] Interview of Malina by James H. Wilson, Jun. 8, 1973, p. 17, transcript in JPL Archives.

[43] Malina, "Jet Propulsion Laboratory," p. 161.

[44] Cf., e.g., Malina's comments in "The U.S. Army Air Corps Jet Propulsion Research Project, GALCIT Project No. 1, 1939-1946: A Memoir," Hall, ed., *Essays on the History of Rocketry*, part II, p. 158, and the comment of Lloyd Berkner, quoted in R. Cargill Hall, "Earth Satellites, A First Look by the United States Navy," ibid., p. 269n9: "During the war our early studies in the Navy showed the orbiting Earth satellite was within the range of our technology. But in 1943 it was clear that space technology, aside from short-range rockets, would not be a factor in the war, so the matter was laid aside. . . ."

extensive program at Caltech and elsewhere to develop guided bombs and short-range rockets.[45]

The efforts of the small group of six individuals around Malina, Parsons, and Forman—with its usual experiences (for early rocketeers) of mishaps and explosions[46]—can be considered during its first few years as in some respects equivalent to the pre-1932 rocket development efforts in Germany. From three important perspectives, however, the period from 1936 to roughly 1939 at the GALCIT rocket research project, as it was then called, was more comparable to the years von Braun spent at Kummersdorf from 1932 to about 1934. First, it is evident that Malina and his fellow rocket researchers had more sophisticated equipment for regulating and measuring propellant pressures and temperatures, chamber pressure, and thrust than did von Braun, by his own testimony, before 1932.[47] The second point of similarity was that both von Braun and Malina were working on dissertations about similar topics at prestigious universities. And thirdly, the group around Malina made extensive use of theory in its research and development efforts, as was also true of developments at Kummersdorf and later Peenemünde.

This last point about theory can be demonstrated in a number of ways. In Malina's memoirs, he repeatedly refers to this use of theory. For example, he states that the initial program of his group included "theoretical studies of the thermodynamical problems of the reaction principle and of the flight performance requirements of a sounding rocket" and experiments to determine problems to be faced "in making accurate static tests of liquid- and solid-propellant rocket engines." This approach, he added, "was in the spirit of von Kármán's teaching."[48] Besides Malina's own comments, written much after the fact but based upon citations of reports contemporary with the efforts of the late 1930s, there is also much evidence in the reports themselves of the theoretical approach being

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[45] Goodstein, *Millikan's School*, pp. 244-260; John E. Burchard, ed., *Rockets, Guns and Targets* (Boston: Little, Brown and Company, 1948), pp. 50-62, 83-209; Conway W. Snyder, "Caltech's *Other* Rocket Project: Personal Recollections," *Engineering & Science* (Spring 1991): 2-13. I am grateful to Cargill Hall for calling the last source to my attention.

[46] See Frank J. Malina, "On the GALCIT Rocket Research Project, 1936-1938," in Frederick C. Durant III and George S. James, eds, *First Steps Toward Space* (Washington, DC: Smithsonian Institution Press, 1974), pp. 121-22. The other three early participants were Apollo M. O. Smith, Hsue-shen Tsien (Chien Hsueh-sen, as he later was known), and Weld Arnold.

[47] See von Braun's typescript, "The Development of German Rocketry Prior to 1945," from the U.S. Space and Rocket Center, pp. 9-10, where he noted that he and his fellow rocket developers at the Raketenflugplatz before 1932 did have a thrust balance but that Colonel Karl Becker, then chief of Ballistics and Ammunition in Army Ordnance, complained about their almost complete lack of "scientific and accurate data on such matters as propellant consumption, specific impulse of your motor, combustion pressure, and the like." Compare that comment with Figure 3 in Malina, "GALCIT Rocket Research Project," p. 120, showing the kind of test setup he and his colleagues were using in Nov. 1936 and his later test stand in Figure 4, p. 122, from 1939.

[48] Malina, "GALCIT Rocket Research Project," p. 114, and see also other references to theory on pp. 115 and 117 among other places in this article and in his "Army Air Corps Jet Propulsion Research Project," pp. 160-161.

used in conjunction with experiment and testing. This is even true of a report written by Parsons in 1937. According to Malina, Parsons was often at odds with the people from Caltech like himself who "felt very unhappy about the lack of sufficient knowledge about the fundamentals, whereas Parsons and Foreman of course were very anxious to get something into the sky." Malina said further "that perhaps his [Parson's] general grasp of the theory of chemistry was sort of global rather than detailed; I mean he was not mathematically talented."[49] Yet Parson's 1937 paper, part of a collection of such early papers that the Malina group called its "bible,"[50] relies upon a number of disparate sources including the American Rocket Society, Goddard, and Sänger. It includes numerous calculations about energy, temperature, velocity, volume, pressure, and theoretical impulse. It provides tabular data for a variety of different chemicals that could serve as propellants for rockets, including hydrogen, alcohol, and trimethyl aluminum. And it compares theoretical values with those obtained experimentally, then speculates about reasons for discrepancies.[51] Other reports and articles from this period also attest to a wide-ranging examination of theoretical and experimental literature from all over the world and to the use of that literature to inform the tests and experiments the Malina group performed.[52]

The character of the project changed in some respects in January 1939, when the National Academy of Sciences (NAS) Committee on Army Air Corps Research accepted von Kármán's offer to study jet assisted take-off (JATO) of aircraft and prepare a proposal for research on the subject in return for $1,000. This led to an NAS contract for $10,000 to this end effective July 1, 1939, and to subsequent contracts from the Army Air Corps and the Navy for JATO units (both liquid- and solid-propellant). It was not until the fall of 1943, in the wake of vague intelligence reports about German missiles, that the U.S. military evinced any interest in surface-to-surface missiles. This led to a contract with Army Ordnance beginning in 1944 to develop such a missile. Meanwhile, the organization that was gradually assuming the identity of JPL had also agreed to

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[49] Wilson interview with Malina, pp. 4, 16.

[50] Malina, "GALCIT Rocket Research Project," pp. 120-121; included were a paper by Bollay from 1935 entitled "Performance of the Rocket Plane" and one by Malina from 1937, "Analysis of the Rocket Motor."

[51] J. Parsons, "A Consideration of the Practicality of Various Substances as Fuels for Jet Propulsion," available in the JPL Archives. John Bluth, the oral historian there, wonders if Parsons wrote this paper by himself, but even if he had help, the paper shows clearly the approach taken by the Malina group.

[52] See, e.g., Frank J. Malina, "Rocketry in California," *Astronautics* 41 (July 1938): 3-6, found in an unnumbered folder in the Frank J. Malina Collection (originally at the California Institute of Technology, which organized it before it moved to the Library of Congress), Box 12, which cites Sänger, the Italian A. Bartocci, and Goddard; Malina, "Report on Jet Propulsion for the National Academy of Sciences Committee on Air Corps Research," Dec. 21, 1938, Malina Collection, Box 9, folder 9.1, which cites two National Advisory Committee for Aeronautics reports as well as Goddard and Sänger and discusses their implications; and the highly theoretical article by Malina, "Characteristics of the Rocket Motor Unit Based on the Theory of Perfect Gases," *Journal of the Franklin Institute* 230 (Oct. 1940): 433-54. The Caltech archives retains a microfiche of the Malina Collection, so it is available both there, together with a guide prepared by Caltech, and at the Library of Congress Manuscript Division, which has the original paper documents.

contracts with the Army Air Forces (AAF) Materiel Command to perform hydrobomb and ramjet engine research.[53]

Thus, like Peenemünde, GALCIT/JPL was involved with considerably more than one project. At first, the number of personnel and the available facilities were limited, although throughout the history of the projects, Malina and his co-workers were able to call upon the considerable equipment and expertise of Caltech, which itself grew in the course of World War II. The annual prewar budget at Caltech had been $1.25 million. In the course of the war, the budget for the separate, short-range rocket project for the National Defense Research Committee (NDRC) of physics professor Charles Lauritsen had grown from $200,000 in 1941 to $2 million a month in 1944, and Caltech's overall personnel had multiplied more than tenfold to almost 5,000.[54] The much more modestly funded and staffed effort under Malina and von Kármán grew slowly from the initial six individuals plus von Kármán to only 85 in May of 1943, 264 in June of 1945 (55 professional, 51 administrative, and 158 skilled and unskilled workers), and 385 in June of 1946.[55]

A couple of important early crises in the development of liquid- and solid-propellant JATO engines will illustrate further the ways in which the GALCIT/JPL team operated. In 1939-1940, Parsons sought a solution to the problem of controlled burning for many seconds in a solid-propellant rocket motor that was critical to the operation of a JATO unit. It was he, apparently, who conceived the concept of "cigarette-burning" whereby the propellant would burn at only one end, but repeated tests of powder compressed into a chamber and coated with a variety of substances to form a seal with the wall of the chamber resulted in explosions. Authorities von Kármán consulted advised him that a powder rocket could not burn for more than two or three seconds. Not satisfied with this expert opinion alone, von Kármán characteristically turned to theory for a solution. After discussing the matter with Malina, he devised four differential equations that described the internal ballistics of the rocket motor and handed them to Malina for solution. Malina discovered that, theoretically, if the combustion chamber were completely filled by the propellant charge and the ratio of the burning propellant to the throat area of the chamber's nozzle as well as the physical properties of the propellant remained constant, then the thrust also would remain constant. In other words, there would be no explosions. Encouraged by these findings, Parsons and others came up with a compressed powder design that worked effectively, after one initial explosion, for 152 successive motors used in successful flight tests of six JATO units on an Ercoupe air-

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[53] For the complex history of these contracts and the overlapping relationships with the various Army and Navy organizations, see Koppes, *JPL*, esp. pp. 18-19; Malina, "ORDCIT Project," pp. 343-47; U.S. Army Missile Command, "History of the Sergeant Weapon System" (c. 1965), pp. 3-4, seen at the Redstone Scientific Information Center; R. C. Miles, "The History of the ORDCIT Project up to 30 June 1946" (n.d.), pp. 2-18, 87-91, copy in the JPL Archives.

[54] Goodstein, *Millikan's School*, p. 245.

[55] "Facilities and Equipment of the Air Corps Jet Propulsion Research Project," May 28, 1943, p. 1, Malina Collection, Box 10, Folder 10.1; F. J. Malina et al., "The Jet Propulsion Laboratory, GALCIT," June 25, 1945, p. 1, Malina Collection, Folder 10.6; [Roger Stanton], "Research and Development at the Jet Propulsion Laboratory, GALCIT," June 1946, p. 4, Malina Collection, Folder 12.12.

Figure 5 Members of GALCIT at March Field, California, August 12, 1941, before take-off of the United States's first rocket assisted takeoff, using a GALCIT-developed solid-propellant JATO unit on an Ercoupe airplane. Left to right, Dr. C. B. Millikan, Dr. Martin Summerfield, Dr. Theodore von Kármán, Dr. F. J. Malina, and Captain H. A. Boushey, Jr., pilot of the airplane. GALCIT photo (JPL).

craft in August of 1941, convincing the Navy to contract for a variety of assisted takeoff motors.[56] After storage under varying temperatures, however, the motors usually exploded. It was then that Parsons' fertile imagination supplied a solution. Apparently watching a roofing operation in June of 1942, he decided that asphalt as a binder and fuel mixed with potassium perchlorate as an oxidizer, would provide a stable propellant. Thus the theory of von Kármán and Malina combined with the practical knowledge and imagination of Parsons yielded what came to be called a castable, composite solid propellant that, with later additions, made large solid propellant rockets possible.[57]

In developing a liquid-propellant JATO, Malina and his co-workers had to accede to the Air Corps's objections to liquid oxygen (used by both the Germans on the V-2 and by Goddard on his rockets and the JATO units he worked on separately for the Navy) as an oxidizer. The Air Corps insisted on an oxidizer that presented fewer problems in production, storage, and transport than the cryogenic oxygen in its more compact liquid form, so Parsons suggested red fuming nitric acid (RFNA), a solution of nitrogen dioxide and nitric acid, as an oxidizer. Although it was poisonous and corrosive, requiring aluminum or stainless steel to contain it, it was more acceptable to the Air Corps than liquid oxygen. In late December of 1939, the GALCIT team performed tests with the RFNA and determined it would burn in an open crucible with gasoline and benzine. Meanwhile, Malina and Hsue-shen Tsien had begun in 1936 to study theoretically the "characteristics of an ideal rocket motor consisting of a chamber of fixed volume and an exhaust nozzle." Tsien was a Chinese student of von Kármán whom the latter described as "an undisputed genius." He had earned a B.S. in mechanical engineering in Shanghai, an M.S. in aeronautical engineering at MIT in 1936, and achieved his Ph.D. in aeronautics and mathematics at Caltech in 1939.[58]

To obtain better experimental data than was available in the existing literature, the group tested gaseous oxygen and ethylene burned in a large combustion chamber with high heat capacity and nozzle dimensions selected to permit low rates of consumption for the propellants, which they supplied from cylinders under high pressure. They injected the propellants into the chamber separately with injection nozzles at the opposite

[56] Andrew G. Haley, *Rocketry and Space Exploration* (Princeton: Van Nostrand, 1958), p. 100. See also the sources cited in note 61.

[57] Gorn, *Universal Man*, p. 87; von Kármán with Edson, *Wind and Beyond*, pp. 245-46; von Kármán with Malina, "Characteristics of the Ideal Solid Propellant Rocket Motor," (JPL Report No. 1-4, 1940) in *Collected Works of Theodore von Kármán* (London: Butterworths, 1956), vol. IV (1940-1951), pp. 94-106; Malina, "Army Air Corps Jet Propulsion Research Project," pp. 169-176, 183-187; Carroll, "Sergeant Missile Powerplant," pp. 123-26. For an exhaustive technical discussion of the castable asphalt propellant known as GALCIT 53 and related technologies used in the JATO units, see J. W. Parsons and M. M. Mills, "The Development of an Asphalt Base Solid Propellant," GALCIT Project No. 1, Report No. 15, Oct. 16, 1942, in JPL Archive.

[58] Alan E. Slater, ed., "Research and Development at the Jet Propulsion Laboratory, GALCIT," *Journal of the British Interplanetary Society* 6 (Sept. 1946): 41; Malina, "Army Air Corps Jet Propulsion Research Project," pp. 160-61, 167, quotation from p. 160. On Tsien, von Kármán with Edson, *Wind and Beyond*, p. 308, and "Biographical Resume" on Tsien in folder 002375 on Tsien in the NASA Historical Reference Collection.

Figure 6 Flight test crew consisted of (left to right) F. S. Miller, J. W. Parsons, E. S. Forman, Dr. F. J. Malina, Capt. H. A. Boushey, Jr., Pvt. Kobe, and Cpl. R. Hamilton.

end of the chamber from the exhaust nozzle and ignited them with an ordinary automotive spark plug. They measured the thrust, chamber pressure, and weights of propellants consumed, keeping a photographic record of the gages.[59] It would appear, however, that there had not been great progress on liquid propulsion as of July 1940 when the group was joined by Martin Summerfield, a roommate of Malina who had completed work on his Ph.D. (awarded in 1941) in the physics department at Caltech in x-rays and infrared radiation. He went to the Caltech library, consulted the literature on combustion chamber physics, and found a text with information on the speed of combustion. Using it, he calculated—much in the fashion of Thiel at Kummersdorf—that the combustion chamber being used by the GALCIT team was far too large, resulting in heat transfer that degraded performance. So he constructed a smaller chamber of cylindrical shape, and it yielded a 20 percent increase in performance. Summerfield also analyzed the heat transfer and heat loss through the combustion chamber. He recalled that von Kármán believed roughly 25 to 30 percent of the heat would be lost, based on information about combustion chambers in reciprocating engines. The aerodynamicist therefore concluded that it would be impossible for the engines to be self-cooling, restricting both their lightness and length of operation. Summerfield's calculations showed that these assumptions about heat transfer were far too high, indicating that it was possible for a self-cooling engine to operate for a sustained period. Subsequent tests measuring the heat transfer confirmed Summerfield's calculations, and Malina learned about the technique of regenerative cooling from James H. Wyld of Reaction Motors, Inc. during one of his trips back east.[60]

For the moment, the group worked with uncooled engines propelled by RFNA and gasoline. Successive engines of 200, 500, and 1,000 pounds of thrust with various numbers of injectors provided some successes but presented problems with throbbing or incomplete initial ignition, leading in both cases to explosions. It was then—after four months of efforts to improve combustion and ignition as well as to stop throbbing—that on a visit to the Naval Engineering Experiment Station in Annapolis in February 1942, Malina learned that Ensign Ray C. Stiff, the chemical engineer in a group headed by Lt. Robert C. Truax, had discovered in the literature of chemistry that aniline ignited spontaneously (or hypergolically, to use the German term) with nitric acid. Malina telegrammed Summerfield to replace the gasoline with aniline. He did so, but it took three different injector designs to make the 1,000-pound engine work. The third involved eight sets of injectors each for the two propellants, with the stream of propellants washing against the chamber walls. This must have provided some film cooling, but Summerfield recalled that after 25 seconds of operation, the heavy JATO units glowed cherry red. Nevertheless, the units successfully operated on a Douglas A-20A bomber

[59] Frank J. Malina, John W. Parsons, and Edward S. Forman, "Final Report for 1939-40," GALCIT Project No. 1, Report No. 3, pp. 4-10, 22-24, available at the JPL Archive.

[60] Most of this paragraph based on my interview with Dr. Summerfield, Sept. 27, 1994, transcript in my possession, pp. 3-8, but cf. Malina, "Army Air Corps Jet Propulsion Research Project," pp. 161-162. For information on Wyld, see Frederick I. Ordway and Frank H. Winter, "Pioneering Commercial Rocketry in the United States of America, Reaction Motors Inc.," *Journal of the British Interplanetary Society* 36 (1983): 542-44 and 38 (1985): 155-158.

for 44 successive firings in April 1942, the first successful operation of liquid JATO in the U.S., leading to orders by the AAF with the newly formed Aerojet Engineering Corporation.[61]

This company, later known as Aerojet General Corporation after its acquisition by General Tire and Rubber Company in 1944-1945, was formed by Malina, von Kármán, Summerfield, Parsons, and Forman plus von Kármán's lawyer Andrew G. Haley in March 1942 to produce the rocket engines developed by the GALCIT group. It did considerable business with the AAF and Navy for JATO units during the war and had become by 1950 the largest rocket engine manufacturer in the world and a leader in research and development of rocket technology. Until the acquisition by General Tire, Aerojet and the GALCIT project retained close technical relations.[62] This was quite different from the relations of Peenemünde and Mittelwerk in many respects, although people from Peenemünde had to perform quality control and oversee production of V-2s at the underground facility.[63]

Although GALCIT/JPL was involved only with JATO work from 1939 to 1944, already in the summer of 1942 the project began designing pumps to deliver liquid propellants to the combustion chamber instead of feeding the propellants by using a gas under pressure. By the fall of that year, project engineers were also working on using the propellants to cool the combustion chamber of a 200-pound-thrust engine.[64] Thus, even before the project resumed formal work on rockets in 1944, it was already addressing technical issues that would contribute to the design of those rockets—both liquid and solid. While JATO remained the focus of the project, it was divided into liquid and solid propellant sections, headed in May 1943 by Summerfield and Parsons respectively, supported by design, data, and materials sections plus one for production and maintenance. Where needed, these were all supplemented by other specialized facilities and

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[61] Malina, "Army Air Corps Jet Propulsion Research Project," pp. 168, 179-180; Slater, ed., "Research and Development at JPL," pp. 42-45; Summerfield interview, p. 8. See also Robert C. Truax, "Liquid Propellant Rocket Development by the U.S. Navy during World War II: A Memoir," in John L. Sloop, ed., *History of Rocketry and Astronautics*, AAS History Series, Vol. 12 (San Diego: Univelt, 1991), pp. 60-61.

[62] Winter and James, "Highlights of 50 Years of Aerojet," pp. 2-3; Malina, "Army Air Corps Jet Propulsion Project," pp. 194-195; Malina, "A Review of Developments in Liquid Propellant Jet (Rocket) Propulsion at the ACJP Project and the Aerojet Engineering Corporation," report prepared for the Special Office of Scientific Research and Development Committee Meeting, Feb. 17, 1944, esp. p. 2, Folder 9.2 of the Malina Collection; letter, Haley to Capt. R. C. Schulte, Asst. Chief of Air Staff/MM and D, Jun. 25, 1943, NA, RG 18, Box 630, File 360.2, which describes the facilities at Aerojet.

[63] See esp. Neufeld, *Rocket and the Reich*, pp. 202-209, 223-230, Manfred Bornemann, *Geheimprojekt Mittelbau: Die Geschichte der Deutschen V-Waffen-Werke* (Munich: Lehrmanns Verlag, 1971), pp. 30-45, 61-75, 105-7, 124-35, and Ordway and Sharpe, *The Rocket Team*, pp. 60-90.

[64] JPL/Monthly Summaries, 1942-1944, summaries for May 1-Jun. 30, 1942, and July 1-July 31, 1943 [sic, misprint for 1942], in Malina Collection, folder 8.1. For the cooling, see the summaries for October and December 1942.

equipment at Caltech itself.[65] Once the project began working on rockets per se, however, it reorganized into a larger number of sections, some devoted to specific technologies such as the liquid and solid propellant rockets, underwater propulsion, and the ramjet while others fulfilled general functions like research analysis, materials research, propellant research, engineering design, and field testing.[66]

The dynamic von Kármán remained director of the project until the end of 1944 when he left to establish the Scientific Advisory Board for the AAF. Malina was chief engineer of the project until he succeeded von Kármán as acting director. But according to Summerfield there was no counterpart at GALCIT/JPL for von Braun at Peenemünde. Instead, Summerfield said, the way the professionals in the project integrated the various components of the rockets and the various developments in fields as disparate as aerodynamics and metallurgy was by the simple expedient of discussing them as colleagues.[67] He seems to suggest that much of this was done informally, but like Peenemünde, JPL also had many formal meetings where such issues were discussed. In addition, the Research Analysis section, headed first by Tsien and then by Homer J. Stewart, did a good deal of what later was called systems engineering for JPL. Stewart had earned a B.S. in aeronautical engineering in 1936 at one of the larger and more advanced aeronautical engineering schools in the country, the University of Minnesota. There, he took lots of mathematics courses. He then studied aeronautics and meteorology at Caltech, where he took a number of physics courses as well as one in compressible fluid theory, earning his Ph.D. in aeronautics in 1940. Stewart recalled that he had joined the project as soon as it had money available to it in 1939, and he had performed some early systems engineering on the JATO units, "performance calculations on take-off runs and what happens with a certain amount of rocket assistance" plus "parametric analysis" and "design objectives." Later in Research Analysis, which he says was shorthand for "system engineering," he and his staff did applied mathematics, solving messy problems and then turning them over to regular engineering groups once they had been resolved enough to be considered routine. They performed trajectory analysis; studied "heat transfer in nozzles, a standard elliptic-equation integration problem"; and external aerodynamics, including testing in wind tunnels.[68]

Another important factor in the process of innovation in rocketry at JPL, as already seen in part, was the amount of information, data, and cooperation received not

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[65] "Facilities and Equipment of the ACJP," pp. 2-3, and "Description of the Experiment Station of the ACJP," p. 3, folders 10.1 and 9.9 of the Malina Collection, respectively.

[66] See Malina et al., "Jet Propulsion Laboratory," p. 2, folder 10.6 of the Malina Collection, and the various "Conference Minutes, ORDCIT Project June 1944-June 1945," folder 4.4 of the Malina Collection.

[67] My interview with Summerfield, p. 25. For the roles of von Kármán and Malina, Malina, "The Jet Propulsion Laboratory," pp. 164, 217-18.

[68] Biographical sheet on Stewart in file 002216 on him in the NASA Historical Reference Collection; interview of Stewart by John L. Greenberg, Oct. 13-Nov. 9, 1982, in the Caltech Archives, pp. 5-9, 73-74, 82-85. For a similar discussion of the role and activities of Research Analysis, followed by a discussion of the other sections, see Miles, "History of the ORDCIT Project," pp. 52-56. My thanks to Dr. Goodstein for permission to cite materials from the Caltech Archives.

only from Caltech but from other sources outside the JPL complex. For example, beginning in 1942 a chemistry group under Bruce H. Sage of Caltech's Department of Chemical Engineering began analysis of chemical problems in propellants for JPL. Sage also made enormous contributions to Lauritsen's shorter-range rocket project in Eaton Canyon, operating a propellant plant around the clock, but he used his expertise to assist the propellant engineers at JPL, as well.[69] Besides Sage and Tsien, others serving as consultants to the project in 1943 alone included the noted aerodynamicist Clark Millikan (son of R. A. Millikan) and the Nobel Prize-winning chemist Linus Pauling, who also did work during the war analyzing double-base solid propellants for a separate NDRC project.[70] By 1945, when JPL began firing its rockets at various ranges in California and New Mexico, the Aberdeen Proving Ground's Ballistics Research Laboratory was gathering radar tracking and ballistic data for JPL. Stewart and his staff could obtain wind tunnel data not only from the 10-foot subsonic wind tunnel at GALCIT but also a supersonic tunnel at Aberdeen Proving Grounds designed in part by von Kármán's former assistant at Caltech, Allen Puckett. The Sperry Gyroscope Company was developing "long-range missile auto-pilots and servo mechanisms" for JPL.[71] In August 1944, Stewart discussed aerodynamic forces with Dr. Wolfgang Benjamin Klemperer from Douglas Aircraft Company, which had build a number of winged missiles and had valuable information to share.[72] These are only some of the examples that could be given of outside information made available to the members of the GALCIT/JPL program. It is impossible to measure their precise influence upon rocket development, but it is highly likely that the synergy resulting from the mixture of backgrounds, talents, and knowledge on the parts of participants contributed significantly to the overall outcome.

Apart from the earlier successes with JATOs, this outcome was essentially threefold. The first achievement was the successful launching in December 1944 of the Private A test rocket. This was a fin-stabilized, 92-inch rocket propelled by a castable asphalt-perchlorate substance known as GALCIT 61-C and four 4.5-inch powder rockets developed by the NDRC and used as boosters. The sixteen rounds that were fired for record, after initial tests and adjustments, achieved ranges averaging about 18,000 yards and a maximum range of 20,000 yards. Besides providing data on trajectories and the

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[69] Malina, "Jet Propulsion Laboratory," p. 218; Goodstein, *Millikan's School*, pp. 252-55.

[70] "Facilities and Equipment of the ACJP," p. 3. On Pauling's other work, see W. A. Noyes, Jr., ed., *Chemistry: A History of the Chemistry Components of the National Defense Research Committee, 1940-1946* (Boston: Little, Brown, 1948), pp. 133-135. Pauling's group developed a method for chromatic analysis of propellants later employed by Aerojet's rival, Hercules Powder Company.

[71] Malina et al., "Jet Propulsion Laboratory, GALCIT," pp. 3, 11-12. For a report of the work Sperry did on control mechanisms for the ORDCIT Project, see Mills, "History of the ORDCIT Project," pp. 132-149. On Puckett, Thomas, "von Kármán's Caltech Students," p. 13.

[72] "Conference Minutes, ORDCIT Project," Aug. 15, 1944, Malina Collection, folder 4.4. This source does not list Klemperer's full name, but presumably it was Wolfgang Benjamin Klemperer listed as a research engineer at Douglas in *Who's Who in World Aviation* (Washington, DC: American Aviation Publications, Inc., 1955), p. 173.

use of boosters, the rocket served as a precursor for later solid propellant rocket developments already discussed.[73]

The second major success of the JPL rocket development effort in this period was the launching of the WAC Corporal sounding rocket, the term WAC standing for Women's Auxiliary Corps or Without Attitude Control, depending upon the source consulted. The Army Ordnance Department had requested that the project investigate the feasibility of a rocket to carry meteorological equipment weighing 25 pounds to a minimum altitude of 100,000 feet. The JPL team redesigned an Aerojet motor that used monoethyline as a fuel and nitric acid mixed with oleum as an oxidizer. The original motor was regeneratively cooled by the monoethyline. JPL adapted the motor to use RFNA as oxidizer and aniline containing 20 percent of furfuryl alcohol as a fuel, thereby increasing the exhaust velocity from 5,600 feet per second to 6,200 feet per second but leaving the thrust at 1,500 pounds for 45 seconds. Boosted by a modified Tiny Tim aircraft rocket developed by the Lauritsen group of the NDRC and guided by a launching tower with three guide rails, the WAC Corporal reached a maximum altitude on October 11, 1945, of between 230,000 and 240,000 feet. Besides achieving this altitude, the WAC Corporal led directly to the successful Aerobee sounding rocket built by Aerojet.[74]

The third area of success for JPL down to the end of the war was the continuing development of the Corporal E missile with an air-pressure system for supplying the propellants to the combustion chamber and the Corporal F, which was pump-fed. In developing both versions of the missile, JPL gained much experience working with pumps, injectors, and other complex features of a liquid-propellant rocket. In some respects, the technology used at JPL may have been more advanced than that actually employed on the V-2, with its cumbersome 18-pot injector system, but before the war's end, the propellant section at Peenemünde had developed a single injector plate to replace the 18 pots with the extensive plumbing they required. However, it was too late to integrate this plate into the production models of the V-2, although it was successfully used in the anti-aircraft rocket, Wasserfall, through the test-flight stage of development. It later became a standard element in the construction of the rockets designed in Huntsville. Meanwhile, in 1947 when the Corporal E came to be flight tested—nearly

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[73] Malina, "ORDCIT Project," pp. 353-54; undated report on the Private A in NA, RG 218, JCS, JNWC, Box 47, folder 354.4, Private A; L. G. Dunn and M. M. Mills, "The Status and Future Program for Research and Development of Solid Propellants," JPL Memorandum No. 4-5, Mar. 19, 1945, p. 21; S. J. Goldberg, "Firing Tests of 'Private A' at Leach Spring, Camp Irwin, California," JPL Report No. 4-3, Mar 14, 1945, pp. 16-25, both reports from JPL Archives. On the development of the 4.5" booster rockets, see Burchard, ed., *Rockets, Guns and Targets*, pp. 54-62.

[74] Malina, "ORDCIT Project," pp. 356-370; Slater, ed., "Research and Development at JPL, GALCIT," pp. 50-54; F. J. Malina, "Development and Flight Performance of a High Altitude Sounding Rocket the 'WAC Corporal'," JPL Report No. 4-18, Jan. 24, 1946, pp. 6-8; S. J. Goldberg, "Field Preparations, Firing Procedure, and Field Results for the WAC Corporal," JPL Report No. 4-22, Nov. 30, 1945, p. 41; Capt. E. W. Bradshaw, Jr. and M. M. Mills, "Development and Characteristics of the WAC Corporal Booster Rocket," JPL Project Note No. 4-30, Feb. 26, 1948, reports from JPL Archives. On the development of the Tiny Tim, see Burchard, ed., *Rockets, Guns and Targets*, pp. 156-64. On Aerobee, see also Winter and James, "Highlights of 50 Years of Aerojet," pp. 15, 19.

two years later than scheduled because of the end of the war—it employed a basically scaled-up version of the WAC Corporal motor. (The Corporal F was dropped.) Like its smaller prototype, it featured a pressure-feed system for the propellants employing compressed air. To lift the nearly six-ton missile required a thrust of 20,000 pounds for 60 seconds. While the first test was successful, succeeding ones revealed problems with the air pressure regulator and with the cooling system. The engine designed to solve these problems employed in modified form an axial-flow feature from the V-2. Incidentally, the version of the Corporal E launched in 1947 was stabilized via a pneumatic autopilot developed by Sperry, showing the continued involvement of that firm in the development of the Corporal.[75]

Conclusion: Influence and Ideas in Later U.S. Spaceflight Activities

These post-war developments begin already to show the intertwining of influences from both Peenemünde and JPL in post-war liquid-propellant rocketry in the United States. Both no doubt continued to have such influences for some time. Quite apart from the direct involvement of von Braun and many of the German engineers and scientists who came to this country in 1945 and afterwards, both programs had vicarious influences that will require much more research to trace. Although JPL got out of the rocket propulsion business in the late 1950s,[76] it continued to exert an influence through Aerojet and through individuals like the engineer George P. Sutton, who had earned a BS (1942) and MS (1943) at Caltech, taught there, worked at Aerojet, and was hired in 1946 by another Caltech engineer already mentioned, William Bollay, to work for the Rocketdyne Division of North American Aviation on the Navaho program.[77] Of course, the Germans from Peenemünde also had close relations with Rocketdyne, which had a continuing involvement in rocket development throughout the period after World War II,

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[75] Koppes, *JPL*, p. 39; William H. Pickering with James H. Wilson, "Countdown to Space Exploration: A Memoir of the Jet Propulsion Laboratory, 1944-1958," in Hall, ed., *History of Rocketry and Astronautics*, Part II, pp. 392-93; Bragg, "Development of the Corporal," pp. 112-118; varying references throughout the JPL Monthly Summaries, Malina Collection, folder 8.1, and the Conference Minutes of the ORDCIT Project, folders 4.4-4.5 on the development of injectors, pumps, cooling, and other propulsion-related technologies during 1942-1945. On the injector plate for the V-2 and later rockets, Reisig, "Peenemünder 'Aggregaten' zur Amerikanischen 'Mondrakete'," p. 74, my interview with Stuhlinger, pp. 31-33, and a letter from Stuhlinger to me, Mar. 3, 1995.

[76] Koppes, *JPL*, esp pp. 77, 95, 105.

[77] Letter, Martin Summerfield to me, Aug. 26, 1994; *Who's Who in World Aviation and Astronautics*, Volume 2 (Washington, DC: American Aviation Publications, Inc., 1958), pp. 431-32 and see entry for Bollay, p. 45; *Who's Who in Space 1966-67* (Washington, DC: Space Publications, Inc., 1965), p. 272. In 1949 Sutton published a book entitled *Rocket Propulsion Elements* of which the sixth edition appeared in 1992, indicating something of his standing as an expert on propulsion.

so it is not easy to untangle the influences of the two programs in liquid propellant rocketry.[78] A very good illustration of the overlapping influences is an undated photograph, probably from the late 1940s or early 1950s, showing Samuel K. Hoffman, general manager at Rocketdyne, and George Sutton, then manager of Advance Design, seated at a table "discussing future rocket propulsion possibilities."[79] Hoffman was one of the people at Rocketdyne with close ties to von Braun and the other Germans.[80] Further complicating the picture, in 1943 von Kármán organized what Malina described as "the first graduate course in jet propulsion engineering in the U.S.A." Taught by the staff at GALCIT and JPL (plus some engineers from local industries) for the rest of the war, with its lectures published by the Air Technical Service command in 1946, repeated as a course in 1948, and supplemented that year by the Army Ground Force's Officer's Guided Missile Course, it "helped to generate expertise in the scientific-engineering community as well as the military," according to Karl Klager, an expert in solid propellant chemistry, and his co-author, Albert O. Dekker.[81]

This incalculable influence of JPL was matched on the German side by the Hermes project in which the Army Ordnance Department, supported under contract by the General Electric Company, worked with the Germans under von Braun to collect and translate technical information about the V-2 and use captured missiles to carry scientific payloads to high altitudes. According to Julius H. Braun, who was involved in the effort, "the Army initiated a massive technology transfer from the rocket scientists to the neophyte U.S. rocket and missile community. There was a steady flow of visitors from industry, government labs, universities and other services." Some of the visitors, Braun said, "went on to become the key scientists, engineers and leaders of the emerging U.S. missile and space program."[82]

As suggested at the outset of this analysis, no doubt the Germans from Peenemünde had a larger influence upon subsequent liquid-propellant rocketry in the U.S. than did JPL, if only because many of them remained active in rocket development at Redstone Arsenal and the Marshall Space Flight Center after JPL shifted its emphasis from propulsion to spacecraft development. But equally clearly, JPL's influence on solid-propellant rocketry was profound, and in developing the liquid-propellant systems

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[78] My interview with Stuhlinger, pp. 31-42.

[79] Photo with caption in Haley, *Rocketry and Space Exploration*, p. 179. Incidentally, in 1959 Sutton sat on NASA's Saturn Evaluation Committee as a representative of the Advanced Research Projects Agency. Chaired by Abe Silverstein, the committee also included Wernher von Braun. See Virginia P. Dawson, *Engines and Innovation: Lewis Laboratory and American Propulsion Technology* (Washington, DC: NASA SP-4306, 1991), p. 174n63.

[80] My interview with Stuhlinger, pp. 42-43; Stuhlinger and Ordway, *Wernher von Braun*, p. 80.

[81] Malina, "Army Air Corps Jet Propulsion Research Project," pp. 195-196; Klager and Dekker, "Early Solid Composite Rockets," p. 3. Copies of the printed lectures, entitled *Jet Propulsion* and edited by H.-s. Tsien, exist in various places including the Malina Collection, folder 7.4; in the text, the preface by von Kármán explains the background of the course, as does the Malina article just cited.

[82] Braun, "Legacy of Hermes," first page of unpaginated paper.

for the Titan series of missiles and space launch vehicles, Aerojet appears to have continued the JPL legacy in virtual independence of German technology.[83] Because of these facts, the similarities as well as the differences in the ways the two organizations went about their rocket development had significant implications for several of the other topics discussed in this volume. While his successes at Peenemünde and Huntsville showed that a genius like von Braun was a real asset to a missile program, the much smaller effort at JPL demonstrated that a successful rocket development effort did not require a full-time genius as a manager. Von Kármán and Tsien were also geniuses, and both made important theoretical contributions. But neither was directly involved at JPL to the extent that von Braun was at Peenemünde and later, although the force of von Kármán's personality and of his teachings on theory and analysis certainly informed the entire effort at JPL. Malina was extremely capable and made important contributions, but his role was partly as theoretician, partly as conduit of ideas from outside of JPL, and partly as an innovator himself. He does not seem to have possessed von Braun's uncanny ability to stimulate others to rethink what they were doing and to promote cooperation. But with the able contributions of people from different backgrounds like von Kármán, Tsien, Parsons, Summerfield, and Stewart, and with a more spontaneous form of cooperation than that von Braun generated, the GALCIT/JPL program had a significant influence on American rocketry. It, like Peenemünde, demonstrated the importance of combining theoretical insights with empirical research and development. Both also illustrated the importance to successful innovation in a complex technical area of seeking out and adapting the ideas and technical discoveries of outsiders. Both, finally, showed the need to bring together people of different backgrounds and talents so their interactions produced creative solutions that might elude a person of Goddard's brilliance working with only a handful of technicians to assist him.

[83] Tom Sprague, "Aerojet: The First 50 Years," pp. 48-51, typescript kindly provided to me by Dr. Robert Gordon, who worked for many years at Aerojet in the area of liquid propulsion and is in the process of editing a history of Aerojet that will incorporate materials from the Sprague study; telephonic interview, Hunley with Gordon, Mar. 22, 1995.

Chapter 2

Organizing for Space: The Popular Culture of Cold War America

Howard E. McCurdy[1]

Since the mid-1980s, the U.S. civilian space program has endured a series of ever more serious political misfortunes. The U.S. space station, publicly announced in 1984 and originally set for deployment in 1994, has been locked for more than ten years in a cycle of redesign and reconsideration. The *Challenger* space shuttle accident in 1986 raised fundamental questions about the management of space exploration endeavors. Congress refused to fund the Space Exploration Initiative after President George Bush proposed it in 1989. General dissatisfaction with NASA management has increased even as the overall failure rate for space flight missions has decreased.[2]

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[1] Howard E. McCurdy is professor of public affairs at the American University, Washington, D.C. A Ph.D. recipient from Cornell University, he is the author of numerous articles on public policy and governmental management and two books on the U.S. space program: *The Space Station Decision: Incremental Politics and Technological Choice* (The Johns Hopkins University Press, 1990) and *Inside NASA: High Technology and Organizational Change in the U.S. Space Program* (The Johns Hopkins University Press, 1993). This chapter is part of a larger study of popular imagination and the U.S. space program supported by the NASA History Office. The author wishes to acknowledge the assistance of Kimberly Kehoe, a graduate student at The American University, for her assistance in conducting the research necessary to produce this chapter.

[2] This has been discussed at length in numerous popular publications. See, as examples, Thomas P. Stafford, et al., *America at the Threshold: Report of the Synthesis Group on America's Space Exploration Initiative* (Washington, DC: Government Printing Office, n.d. [1991]); "Space Program Faces Costly, Clouded Future," *Congressional Quarterly Weekly Report*, April 5, 1986, p. 732; "NASA Cuts Slow Ambitious Plans," *Congressional Quarterly Almanac 1990* (Washington, DC: Congressional Quarterly, 1991), p. 435; "Bush Goes on the Counterattack Against Mars Mission Critics," *Congressional Quarterly Weekly Report*, June 23, 1990, p. 1958; *Congressional Quarterly Weekly Report*, December 19, 1992, p. 3906.

This chapter suggests that NASA's political problems arise not only from current events, which are themselves powerful determinants, but also from a fundamental change in the popular culture that underpins space exploration. In brief, a gulf is growing between popular beliefs and U.S. space policy. NASA's approach to space exploration, legitimized by President John F. Kennedy's 1961 decision to go to the Moon, received its impetus in response to a Cold War culture that no longer exists. Some of the tenets of that culture, such as beliefs about the military significance of bombs in space, have turned out to be false. Whenever beliefs diverge significantly from public policy, affected agencies encounter the sort of political turbulence NASA has recently faced.

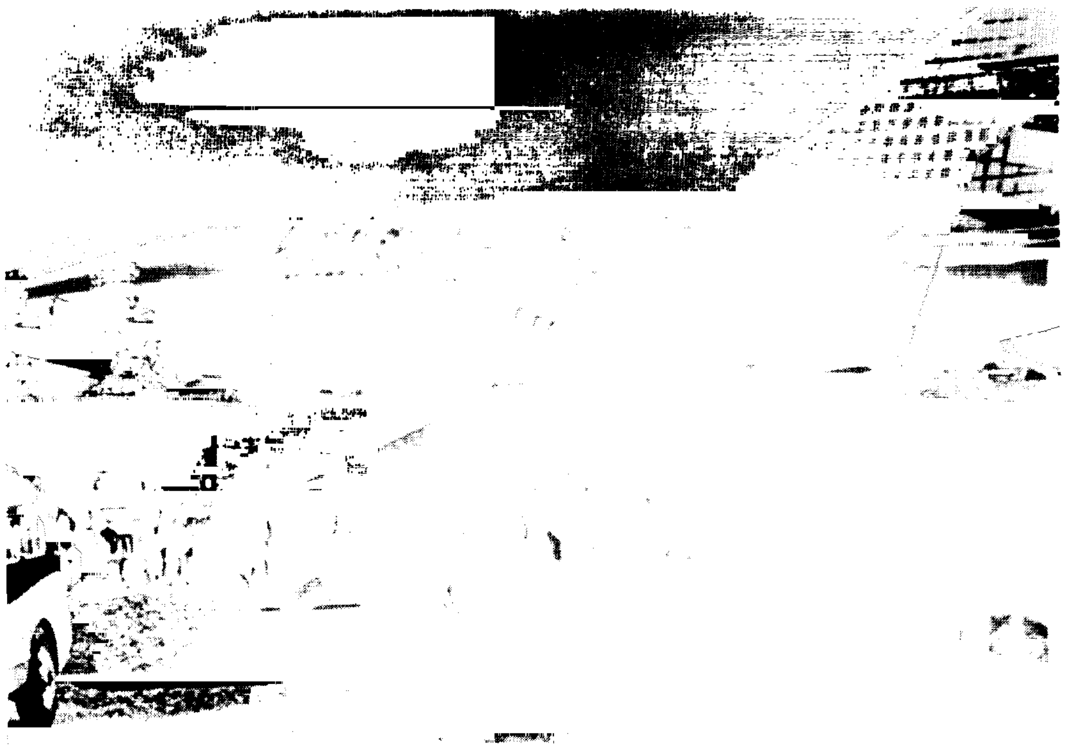

Figure 1 Popular conceptions of spaceflight have always been important in the development of public policy about the issue. This still photograph from Paramount Studio's 1951 feature, *When World's Collide*, depicted a "Space Ark" being built for escape from the Earth. The ark bears a striking resemblance to the V-2 rocket of World War II, and depicted for the American public the possibility of spaceflight as a realizable goal in the near term. The confluence of technical possibility with public belief fostered a climate in which the reality of spaceflight could be achieved. Famed space artist Chesley Bonestell provided technical and artistic support for this film. Photo from Arfor Picture Archives.

All public policies depend upon a supporting set of beliefs for their dissemination. As those beliefs are promulgated through the communication media, they become part of popular culture. Popular culture consists of the ideas, mythology, and arts favored by the great mass of people. The rise of the modern welfare state occurred because the public at large discarded the idea that poverty was an act of God. The conservation movement waited for the public to abandon traditional views of wilderness areas as savage and dangerous places. In the same way, the U.S. civilian space effort required an underlying rationale. Originally that rationale linked the desire for ambitious space exploration to concern over the outcome of the Cold War, in particular to the belief that the nation that controlled space would control the Earth. As the Cold War disappeared, so did much of the consensus supporting ambitious exploration.

Two Space Programs

In the 1950s, as rockets first began to prove their ability to reach space, public officials in the U.S. faced a choice between two fundamentally different space programs. A controversy inside the Eisenhower administration took place over which of these two programs would be supported as official policy. Despite Eisenhower's efforts to resist it, Cold War hysteria gave a decisive advantage to the more ambitious alternative.

The space program that the U.S. eventually adopted had been proposed in a number of forums by both science fiction fans and serious rocketeers. David Lasser, founding president of the American Institute of Aeronautics and Astronautics (then the American Interplanetary Society), published a book on *The Conquest of Space* in 1931 that proposed an ambitious program of lunar and planetary exploration. Willy Ley published a series of books on rocketry and space travel that reached a wide audience beginning in the 1940s. In 1952 *Collier's* magazine began a series of articles on the future of space travel, followed by the three-part Disney television series on space travel that began in 1955. The latter transformed Wernher von Braun into an American media celebrity and one of the principal exponents of interplanetary exploration. NASA's 1959 long-range plan embraced the order of exploration set out in these works, as did the report of the 1969 Space Task Group and the 1986 National Commission on Space. The various plans set as their ultimate goal the movement of humans into space supported by an extensive infrastructure of space stations, advanced transportation systems, Earth-orbiting satellites, and planetary probes.

The space program that the U.S. rejected was most forcefully advanced during the 1950s by President Dwight Eisenhower and his Science Advisory Committee, headed by James R. Killian. It found expression in a number of subsequent documents, including the 1961 report to President-elect John F. Kennedy by his Ad Hoc Committee on Space (chaired by Jerome B. Wiesner) and a 1970 report of a future president's science advisory committee. The Eisenhower alternative disappeared with Kennedy's 1961 decision to establish a crash program to send Americans to the Moon. As the vision of the adopted program came to dominate U.S. popular culture, so the memory of Eisenhower's alternative tended to fade.

Figure 2 James R. Killian taking the oath of office as the President's Science Advisor, November 15, 1957, while President Eisenhower looks on. The oath is being administered by Assistant to the President Sherman Adams. Photograph from the National Archives and Records Administration, Washington, DC.

Eisenhower's space program differed in a number of respects from the one the government came to embrace. It placed a great deal more emphasis upon satellite technology. During the mid-1950s, President Eisenhower was preoccupied with the need to conduct surveillance activities of the Soviet Union and its growing nuclear capability. As the 1960 downing of the U.S. U-2 reconnaissance plane revealed, aircraft overflights had severe shortcomings. Eisenhower authorized the Vanguard satellite program in part because he needed to establish the principle of overflight (namely that a satellite did not intrude upon a nation's air space when crossing its territory), and an internationally supported scientific satellite served this purpose better than a military launch.[3] The satel-

[3] Constance McLaughlin Green and Milton Lomask, *Vanguard: A History* (Washington, DC: Smithsonian Institution Press, 1971).

lite-based space program that Eisenhower favored was eventually adopted by the U.S. Department of Defense, which has relied extensively upon satellites for its extraterrestrial needs.

Commensurate with the emphasis upon satellite technology, Eisenhower's space program de-emphasized the role of humans in space. Eisenhower steadfastly refused to approve any "manned" space flight program that went beyond the single-seat Mercury capsule, which Eisenhower accepted to ascertain whether humans could function in the void. Eisenhower's advisory committee admitted that adventurous humans would someday conduct exploration missions beyond the Earth, but refused to speculate when. "Remote-controlled scientific expeditions to the moon and nearby planets could absorb the energies of scientists for many decades," his committee wrote.[4]

Eisenhower's alternative placed a great deal more emphasis upon space science than upon engineering feats. "Scientific questions come first," his advisory committee argued, when measuring "the value of launching satellites and sending rockets into space." Eisenhower was prepared to compete with the Soviet Union in scientific discoveries, where he saw the U.S. holding a substantial lead. He wanted to weigh the value of discoveries from space, moreover, against the benefits to be gained from investigation on Earth. "Many of the secrets of the universe will be fathomed in laboratories on earth," committee members wrote, and the national interest required "that our regular scientific programs go forward without loss of pace."[5] Eisenhower had no interest in entering into a race with the Soviet Union that depended upon large rocket boosters, where scientific questions took a back seat to engineering capability and the Soviets already held a commanding lead.

Eisenhower did not want to set up a Manhattan-type organization to explore space, strongly resisting suggestions that he engage the Soviet Union in a crash program for superiority in space. His desire for a balanced budget would not allow him to respond to every Cold War contingency, and he feared that a crash program for space would divert resources from more pressing priorities. Interviewed after leaving the White House in 1962, he questioned the wisdom of President Kennedy's decision to race to the Moon.

> Why the great hurry to get to the Moon and the planets? We have already demonstrated that in everything except the power of our booster rockets we are leading the work in scientific space exploration. From here on, I think we should proceed in an orderly, scientific way, building one accomplishment on another, rather than engaging in a mad effort to win a stunt race.[6]

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[4] President's Science Advisory Committee, *Introduction to Outer Space* (Washington, DC: Government Printing Office, 1958), p. 10.

[5] *Ibid.*, pp. 6, 15.

[6] "An Interview with Dwight Eisenhower," *Saturday Evening Post*, August 6, 1962, p. 24.

Even some NASA officials favored the slower approach. In their 1959 long-range plan, for example, lunar landings were set "beyond 1970" after the U.S. had completed an Earth-orbiting space station.[7]

NASA officials serving during the Eisenhower administration sought to merge the "manned" and "unmanned" space flight programs. They created a single office of space flight at NASA headquarters for both human and machine flight. They planned to create a single space projects center for both human and machine flight at what eventually became the Goddard Space Flight Center in Maryland.[8] That center would oversee both the newly created Project Mercury and NASA's scientific satellite programs. Technical requirements for the race to the Moon dissolved this intent. NASA officials created a separate headquarters office for Manned Space Flight as part of a full-scale 1961 reorganization. Texas politicians, including Congressman Albert Thomas, head of the House Appropriations Subcommittee that oversaw NASA's budget, urged NASA to build an entirely new field center near Houston to mount the expeditions to the Moon. Had Eisenhower's alternative prevailed, it is quite possible that NASA human and robotic programs would have been merged within a single space flight center, dampening the schism that subsequently developed between "manned" and "unmanned" activities.[9]

The organizations out of which NASA was formed, notably the National Advisory Committee for Aeronautics (NACA), possessed a strong tradition of in-house work. Many NASA officials believed that they should build prototypes of new systems in their own laboratories before turning to industry.[10] In fiscal year 1960, the last full year of the Eisenhower administration, NASA officials spent 32 cents out of every obligated dollar on in-house projects. NASA's first two administrators, T. Keith Glennan and James E. Webb, favored a more extensive system of contracting out, both as a means of building up the U.S. aerospace industry and building up political support for NASA. Crash programs clearly favored their position, since contractors could mobilize facilities and people more quickly than civil servants. By the mid-1960s, NASA officials were contracting out more than 90 percent of their $5 billion annual obligation budget.[11]

NACA also had a strong tradition of decentralization, in which technical centers in the field carried out agency work without much interference from what was then a small

[7] NASA, Office of Program Planning and Evaluation, "The Long Range Plan of the National Aeronautics and Space Administration," December 16, 1959, table I, NASA Historical Reference Collection, NASA History Office, NASA Headquarters, Washington, DC.

[8] Homer E. Newell, *Beyond the Atmosphere: Early Years of Space Science* (Washington, DC: NASA SP-4211, 1980), pp. 243-47; Loyd S. Swenson, James M. Grimwood, and Charles C. Alexander, *This New Ocean: A History of Project Mercury* (Washington, DC: NASA SP-4201, 1966).

[9] Henry C. Dethloff, *"Suddenly Tomorrow Came . . .": A History of the Johnson Space Center* (Washington, DC: NASA SP-4307, 1993), pp. 35-51; J.D. Hunley, ed., *The Birth of NASA: The Diary of T. Keith Glennan* (Washington, DC: NASA SP-4105, 1993), pp. 14-15.

[10] Howard E. McCurdy, *Inside NASA: High Technology and Organizational Change in the U.S. Space Program* (Baltimore: Johns Hopkins University Press, 1993), pp. 25-60.

[11] NASA, "Annual Procurement Report," fiscal year 1978, p. 78, NASA Historical Reference Collection.

headquarters corps. This tradition was incorporated into NASA at its creation, as NACA leaders took over many key posts. Large multi-center programs on the scale of Project Apollo, however, created strong pressures to centralize. Centralization eventually won out. In 1963 NASA executives reorganized the agency so that center directors reported directly to program chiefs in Washington, D.C. rather than to the top of the organization. NASA executives also began to import officials from the Air Force ballistic missile program, which was more centralized than NASA, to run Project Apollo and replace the NACA old guard. The agency never fully returned to the old system once the lunar goal was achieved.

The Choice

Space boosters favored a program of lunar and planetary exploration far more ambitious than Eisenhower was willing to embrace. They found strong support among the

Figure 3 A strong tradition of in-house, collegial work is demonstrated in this 1942 photograph from the NACA's Aircraft Engine Research Laboratory in Cleveland, Ohio. Later renamed the Lewis Research Center, this facility became a part of NASA in 1958. NASA Photograph number C-1188, September 21, 1942.

rank and file of NASA during the late 1950s, if not among its top leaders. "The ultimate objective of space exploration," a special committee of NASA civil servants stated in 1959, "is manned travel to and from other planets."[12] Eisenhower never approved those plans.

Nearly one hundred years of science fiction and 25 years of space fact had created a small but committed band of exploration devotees. Science fiction of the "Flash Gordon" type excited a small audience, but did not significantly raise expectations about space travel among the public at large. Non-fiction works such as the Disney series

Figure 4 Science fiction was a staple in Hollywood from the 1930s, but few Americans equated the fantasy depicted in such films as this 1936 "Flash Gordon" serial with the possibility of space flight. Here the Emperor Mingo sits on his throne as Flash Gordon, played by Buster Crabbe (Right), and Dale Arden, played by Jean Rogers (Left) are brought before him. Photograph from the collection of Frederick I. Ordway III.

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[12] NASA, "Minutes of Meeting of Research Steering Committee on Manned Space Flight," NASA Headquarters, May 25-26, 1959, p. 2, NASA Historical Reference Collection.

helped to convince the public that space travel was real, and raised expectations, but it was insufficient to win government approval for broad-based programs that went much beyond satellite research and Project Mercury.[13]

Eisenhower's alternative would have established a space program with much more emphasis upon satellites, robotics, and science. It would have avoided the "boom and bust" cycle of crash programs which in turn would have favored the traditions of in-house work and decentralization that the first NASA employees preferred. It likely would have led to a closer relationship between human and automated space activities. Normally, the president plays a leading role in defining the scope and direction of the U.S. space program. In this case, however, popular culture undercut Eisenhower's alternative. It did so because advocates of grander schemes were able to attach their vision to public anxiety over the Cold War.

Following the launch of Sputnik I and II in the fall of 1957, the House Space Committee attacked Eisenhower's alternative as a "beginner" space program that failed to show "proper imagination and drive." Committee staff members urged the administration to mobilize facilities throughout the nation in order to develop manned space stations, build large launch vehicles, and dispatch rockets to nearby planets.[14] Both the U.S. Air Force and U.S. Army drew up plans to put the first human into space, and NACA Director Hugh L. Dryden announced that his agency was prepared to supervise "the travel of man to the moon and nearby planets."[15] A special Senate committee led by majority leader Lyndon B. Johnson pressed for a more aggressive space program and issued recommendations for creating one.

Discontent with the Eisenhower space alternative reached near-hysterical proportions during this time.[16] Public attention fixed on the relationship between the Cold War and the space race. "Control of space means control of the world," Senate majority leader Lyndon Johnson told his colleagues in 1958.[17] Attempts by people in the Eisenhower administration to dispel this perception simply encouraged the belief that the president was inept and did not understand the nature of the challenge.

It is hard for people now separated from the events of the 1950s to appreciate how much the possibility of nuclear war preoccupied American popular culture during the era. U.S. citizens had emerged from an exhausting world war, during which their homeland was essentially secure from enemy attack, to find that horrible weapons could now

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[13] Frederick I. Ordway and Randy Liebermann, *Blueprint for Space: Science Fiction to Science Fact* (Washington, DC: Smithsonian Institution Press, 1992).

[14] National Advisory Committee for Aeronautics to Dr. Killian's Office, August 6, 1958, NASA Historical Reference Collection.

[15] Swenson, Grimwood, and Alexander, *This New Ocean*, pp. 91-101; Hugh L. Dryden, "Space Technology and the NACA," *Aeronautical Engineering Review*, March 1958, p. 33.

[16] Robert A. Divine, *The Sputnik Challenge: Eisenhower's Response to the Soviet Satellite* (New York: Oxford University Press, 1993).

[17] Robert Dallek, *Lone Star Rising: Lyndon Johnson and His Times* (New York: Oxford University Press, 1991), p. 531.

reach their shores. The Soviet Union learned how to fabricate atomic and thermonuclear weapons (using U.S. secrets, anti-communist forces charged). Schools required children to practice civil defense drills and techniques for shielding themselves from nuclear blasts. A favorite technique required school children to dive beneath their desks at the sign of the first thermonuclear flash. Whole cities practiced evacuations and warning sirens wailed weekly in civil defense tests. Citizens dug bomb shelters underneath their homes. The exercises seem humorous by modern standards, but they contributed significantly to public anxiety about an atomic attack during the 1950s.

For the most part, the people promoting space exploration in the popular media did so for reasons of adventure and discovery. Adventure and discovery, however, could not elicit the billions of dollars required to mount an aggressive exploration program.[18] National security considerations could, particularly among those who believed space to be the "high ground" from which the Cold War would be decided. The parsimony that threatened to relinquish control of outer space to the Soviet Union appeared incomprehensible to many Americans. George Reedy, one of Lyndon Johnson's principal aides, predicted that Eisenhower's inattentiveness to the space issue "would blast the Republicans out of the water."[19]

The perception of space as the "high ground" of the nuclear age began to gain popular acceptance in the late 1940s. In 1948 readers of *Collier's* magazine were treated to an article titled "Rocket Blitz From the Moon." The article opened with an illustration of two V-2 shaped rockets rising out of lunar craters with a dome-shaped control center in the lunar background. On the adjoining page, two large fireballs spread across an aerial view of New York City.[20] The nuclear blasts, drawn with stark realism by space artist Chesley Bonestell, were part of a larger literature depicting the effects of a surprise nuclear attack upon the United States. The danger of surprise attacks had been burned into the national consciousness less than ten years earlier by the Japanese attack on Pearl Harbor. Bonestell painted a number of nuclear holocaust pictures, including the cover for the August 5, 1950, *Collier's* magazine issue that showed an atomic blast leveling Manhattan from the point of view of an airplane approaching La Guardia airport. A similar air burst graced the April 21, 1953 issue of *Look*.[21]

Promoters of space exploration warned the American public of the military implications of space. In the August 30, 1947, issue of *Collier's* magazine, science fiction writer Robert A. Heinlein teamed up with Navy Captain Caleb Laning to explain how the absence of a space corps would leave the U.S. defenseless.

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[18] George H. Gallup, *The Gallup Poll: Public Opinion, 1935-1971* (New York: Random House, 1972), 3:1720.

[19] Dallek, *Lone Star Rising*, p. 529.

[20] Robert S. Richardson, "Rocket Blitz from the Moon," *Collier's*, October 23, 1948, pp. 24-25.

[21] Ron Miller and Frederick C. Durant, *Worlds Beyond: The Art of Chesley Bonestell* (Norfolk, VA: Donning, 1983); John Lear, "Hiroshima, U.S.A.," *Collier's*, August 5, 1950, cover; William L. Laurence, "How Hellish Is the H-Bomb?" *Look*, April 21, 1953, p. 31.

> Once developed, space travel can and will be the source of supreme military power over this planet—and over the entire solar system—for there is literally *no* way to strike back from ground, sea, or air, at a space ship, whereas the space ship armed with atomic weapons can wipe out anything on this globe.[22]

Writers for the March 22, 1952, issue of *Collier's* magazine, devoted primarily to the peaceful uses of space, did not pass up the opportunity to preach the dangers of this new technology in the wrong hands. "There will also be another possible use for the space station," Wernher von Braun added to his famous article on the orbital outpost. "It can be converted into a terribly effective atomic bomb carrier." In their introduction to the series on what they called the inevitable conquest of space, the editors of *Collier's* magazine repeated von Braun's warning that "a ruthless foe established on a space station could actually subjugate the peoples of the world."

> The U.S. must immediately embark on a long-range development program to secure for the West "space superiority," If we do not, somebody else will. That somebody else very probably would be the Soviet Union.

The editors agreed that the military advantages of bombs in space would be so great that "whoever is the first to build a station in space can prevent any other nation from doing likewise."[23]

Hollywood helped to spread beliefs about the military importance of space in a number of early science fiction films. In the 1950 movie *Destination Moon*, space enthusiasts turned to industry executives to finance the expedition. Funds flowed freely once a retired military general explained:

> We're not the only ones planning to go there. The race is on, and we better win it, because there is absolutely no way to stop an attack from outer space. The first country that can use the moon for the launching of missiles will control the earth. That, gentlemen, is the most important military fact of our century.[24]

As nuclear and space anxieties reverberated through the popular culture, public officials repeated the line. Democratic Senator Stuart Symington of Missouri announced in a 1957 Veteran's Day address that "the race for the conquest of space is today's major engagement in the technological war. We must win it, because the nation which dominates the air spaces will be in a position to dominate the world." U.S. Air Force Chief of Staff Thomas D. White observed in 1957 that "air and space are an indivisible field of operations. . . . Those who have the capability to control the air are in a position to exert control over the land and seas beneath." Brigadier General Homer A. Boushey explained to the National Press Club in early 1958 that "from an energy standpoint, only

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[22] Caleb B. Laning and Robert A. Heinlein, "Flight Into the Future," *Collier's*, August 30, 1947, p. 36.

[23] "Man Will Conquer Space Soon," *Collier's*, March 22, 1952, pp. 23, 74.

[24] George Pal, *Destination Moon* (1950). Also see Spaceways (1952) and *Riders to the Stars* (1954).

one-fifth or one-sixth the energy is required to shoot a warhead from the Moon to Earth, as vice versa." Then Senator John F. Kennedy agreed during the 1960 presidential campaign that "if the Soviets control space they can control earth, as in past centuries the nation that controlled the seas dominated the continents."[25]

Such statements exasperated Eisenhower and his advisers, who mightily tried to explain the physics involved. "I don't know that anyone knows how you would rule the world with a space station," Secretary of Defense Charles Wilson remarked in 1954.[26] The president's science committee tried to convince Americans concerned about orbiting bombs that "an object released from a satellite doesn't fall." Interviewed for a 1958 issue of *Reader's Digest*, Chief of Naval Operations Arleigh Burke tried to explain that "IRBMs and ICBMs are more practical" than bombs in space. The Science Advisory Committee summed up the arguments:

> Much has been written about space as a future theater of war, raising such suggestions as satellite bombers, military bases on the moon, and so on. For the most part, even the more sober proposals do not hold up well under close examination.[27]

Following the Sputnik launches, presidential assistant Maxwell Rabb announced that the satellite was "without military significance" and Eisenhower himself in a nationally televised address assured the American public that "the over-all military strength of the free world is distinctly greater than that of the communist countries."[28]

These reassurances did little to alleviate the impression that the Eisenhower White House had become what Washington insiders labeled "the tomb of the well-known soldier."[29] National news outlets reporting the president's reassurances gave equal time to space cassandras preaching national doom. In a feature article in *Life* magazine shortly after the Sputnik launch, scientist George R. Price argued that "unless we depart utterly from our present behavior, it is reasonable to expect that by no later than 1975 the United States will be a member of the Union of Soviet Socialist Republics."[30] Even the president's science adviser, James Killian, acknowledged the difficulty of overcoming public perceptions.

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[25] Lee D. Saegesser, "High Ground Advantage," NASA Historical Reference Collection. Also see John F. Kennedy, "If the Soviets Control Space," *Missiles and Rockets*, October 10, 1960, p. 12.

[26] Saegesser, "High Ground Advantage."

[27] President's Science Advisory Committee, *Introduction to Outer Space*, p. 12; Paul Palmer, "Soviet Union vs. U.S.A.—What Are the Facts?" *Reader's Digest*, April 1958, p. 44.

[28] Divine, *Sputnik Challenge*, pp. xv, 46.

[29] *Ibid.*, p. 47.

[30] George R. Price, "Arguing the Case for Being Panicky," *Life*, November 18, 1957, p. 126. See also "Stepping Up the Pace," *Newsweek*, October 21, 1957, pp. 30-34, and "The Feat that Shook the Earth," *Life*, October 21, 1957, pp. 19-35.

> Sputnik I created a crisis of confidence that swept the country like a windblown forest fire. Overnight there developed a widespread fear that the country lay at the mercy of the Russian military machine and that our government and its military arm had abruptly lost the power to defend the homeland itself, much less to maintain U.S. prestige and leadership in the international arena.[31]

Public hysteria over space manifest itself in astonishing ways. One of the most bizarre was the Unidentified Flying Object (UFO) phenomenon. Beginning in the late 1940s, Americans in ever increasing numbers began to report encounters, both visual and personal, with beings from outer space, including some by otherwise reliable witnesses. Sightings increased sharply after the orbiting of Sputnik I on October 4, 1957. Of the 1,178 reported sightings in 1957, 60 percent occurred in the last three months of the year.[32] Discounting the suggestion that aliens actually stepped up observations after the first Earth satellite, one is left with the explanation that the sightings represented some form of hallucination triggered by hysteria over the Cold War. Astronomer Carl

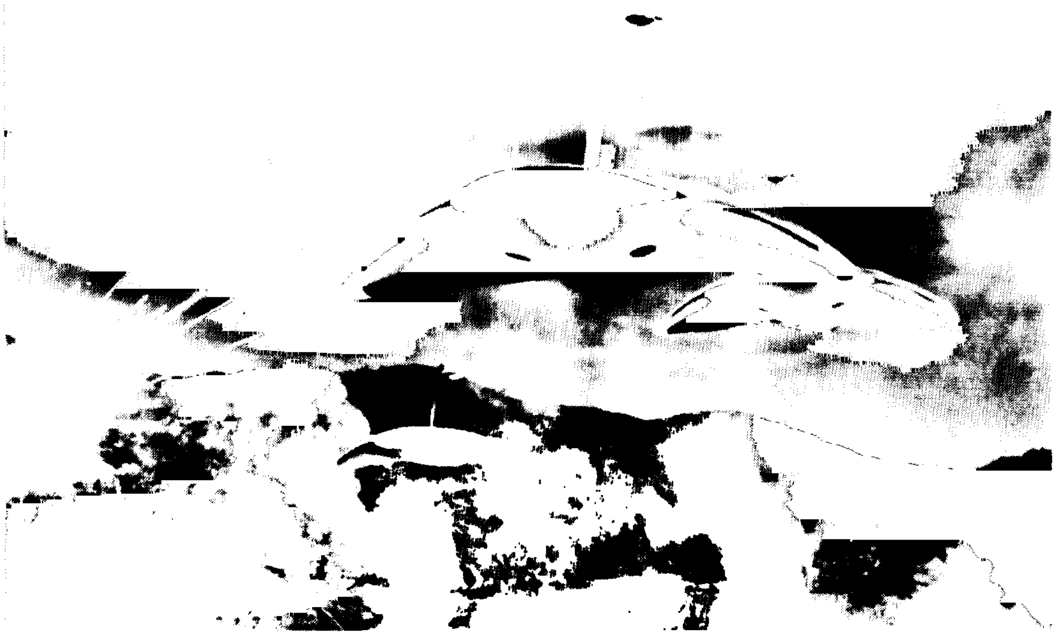

Figure 5 Hollywood played upon the UFO hysteria with a feature film about an invasion from Mars. Here three Martian space vehicles attack military forces in *War of the Worlds* (1953). Photograph from the collection of Frederick I. Ordway III.

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[31] James R. Killian, *Sputnik, Scientists, and Eisenhower* (Cambridge: MIT Press, 1977), p. 7.

[32] Lawrence J. Tacker, *Flying Saucers and the U.S. Air Force* (Princeton, NJ: D. Van Nostrand Co., 1960), p. 82-83; also "If You're Seeing Things in the Sky," *U.S. News and World Report*, November 15, 1957, pp. 122-126.

Sagan has suggested that such an interpretation explains both the modern phenomenon and similar reports during medieval times of encounters with demons.[33]

Implications

Although one of the most dramatic examples, the space program is not the only case in which popular culture has shaped public policy. Closely allied with the space race was the so-called "missile gap" brought up by candidate Kennedy during the 1960 presidential campaign. Appealing to public anxiety over nuclear war and Eisenhower's own admission of Soviet booster superiority, Kennedy charged that the Republican administration had allowed the U.S. to fall behind in ballistic missile capability. As Eisenhower knew from U.S. reconnaissance activity (and Kennedy learned once he became president), the charges were groundless. The Soviet intercontinental ballistic missile capability was puny compared to that of the United States, a fact that helped Kennedy stare down the Soviets during the Cuban missile crisis in 1963.[34] During the 1960 campaign, however, the charge struck a responsive cord in a popular culture that had been bombarded with holocaust images and Soviet space spectaculars. Because the charge seemed to be true (and because Eisenhower could not state the truth without revealing U.S. reconnaissance capability), the public believed Kennedy. The issue helped Kennedy win the 1960 presidential election.

Popular beliefs can create cultural fashions or fads that in turn shape public policy. One such fashion helped to create the homelessness problem of the 1980s. The counterculture revolution of the 1960s spread distrust of authority as one of its central tenets. In 1962 Ken Kesey published an influential statement of that philosophy. His best-selling novel, *One Flew Over the Cuckoo's Nest*, depicted conditions at the Oregon State Mental Institution as seen from the point of view of one of its inmates. Kesey's novel subsequently became a Broadway play and a movie with Jack Nicholson in the leading role. The story expressed the freedom from and freedom to philosophy at the heart of the 1960s counterculture. Kesey depicted state-run psychiatric treatment as offering little more than imprisonment, manipulation, humiliation, and torture. It became fashionable to characterize large state institutions as places that made people crazy rather than well. This philosophy was translated into public policy as legal aid groups such as the American Civil Liberties Union brought suits seeking to place mentally ill persons in the "least restrictive environment." Public officials contemplated community mental health centers as an alternative to state institutions. Large state hospitals released their patients, but governments did not sufficiently fund local clinics. Without state institutions or commu-

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[33] Carl Sagan, "Are They Coming for Us?" *Parade Magazine*, March 7, 1993.

[34] See William E. Burrows, *Deep Black* (New York: Random House, 1986).

nity shelters in which to receive medical aid, large numbers of mentally troubled persons found themselves on the streets.[35]

A more recent example of a cultural fashion concerns Vice President Albert Gore's effort to restructure the executive branch of government. That effort draws its primary inspiration from a book titled *Reinventing Government* by David Osborne and Ted Gaebler. Both the book and Vice President Gore's "National Performance Review" seek to debureaucratize the government by injecting competition into service delivery and replacing rules with a concern for results.[36] Empirical evidence supporting the reforms is very thin. Osborne's book contains the same sort of preachy enthusiasm and anecdotes that propelled the earlier management text *In Search of Excellence* onto best-seller lists. Although the proposed reforms may not save money or improve the delivery of public services, the Osborne-Gore effort touches such deeply held beliefs within U.S. popular culture that many people believe the techniques to be effective even in the absence of confirming evidence.

The fashionableness of anti-bureaucratic beliefs can be traced back to the American Revolution. Thomas Jefferson, the founder of the modern Democratic party, organized the party around the popular philosophy of local rule and limited federal government. He was so embarrassed by his excessive use of executive power that he refused to allow any mention of his service as president to be placed over his grave. Anti-institutional feelings permeate the works of Mark Twain, the preeminent American novelist of the 19th century. Huckleberry Finn rows away toward the territories at the end of his novel in order to escape the corrupting influences of civilization. The art and novels of Franz Kafka, Edvard Munch, Albert Camus, and George Orwell all received a strong reception in the United States because of their anti-institutional tone. Stupid government bureaucrats have been a staple fare in American cinema from early science fiction to modern movies like "Ghostbusters." Anti-institutionalism has been a favorite theme of American writers such as Kesey, Joseph Heller, Kurt Vonnegut, Jack Kerouac, and J.D. Salinger. Distrust of governmental institutions is deeply ingrained in American popular culture. Government reforms that appeal to that belief do not require evidence to prove their efficacy because the beliefs are so widely perceived to be true.

Conclusion

In the U.S. space program, popular beliefs and reality eventually diverged. Space boosters were able to win support for their ambitious program of exploration and settlement (and the big organization required to prosecute it) because of the popular belief in world domination through space. Subsequently, this prophecy failed. Bombs in space were not as effective as land and sea based missiles, as Eisenhower knew. The Soviet

[35] See Myron Magnet, *The Dream and the Nightmare: The Sixties' Legacy to the Underclass* (New York: William Morrow and Company, 1993).

[36] See David Osborne and Ted Gaebler, *Reinventing Government* (Reading, MA: Addison-Wesley Publishing Co., 1992).

Mir space station did not allow it to conquer the world. The Cold War disappeared and the connection between control of space and military superiority grew more tenuous in the public mind. Once military justifications disappeared, so did much of the motivation for an ambitious space program.

Social scientists for some time have studied the effects of failed beliefs.[37] True believers do not automatically abandon their cause when reality intrudes in discomforting ways. True believers rarely admit that they were wrong or change their behavior, especially those who remain close to the original group. Instead they increase their level of proselytizing, working hard to spread the underlying gospel. They seek out new beliefs to validate their old behavior and new explanations as to why initial prophecies failed. Sometimes they deny that their prophecies in fact did fail. (After all, the Soviet Union did lose the Cold War after it lost the race to the Moon.)

In trying to maintain their faith in an unfamiliar world, true believers often encounter a turbulent environment. They experience difficulty winning new converts. People on the outside grow more skeptical and critical of the primary group. Eventually the believers reorient their beliefs, generally in ways that allow them to maintain their basic cause.

Much of this applies to the U.S. space program. Debate over the wisdom of U.S. space goals grew more partisan and ideological as the Cold War ended. Space advocates tried new rationales for continuing endeavors, such as international cooperation and the value of exploration. The press and the public at large grew more skeptical of the space program. Some of this can be blamed on current events such as the bureaucratization of NASA, loss of the space shuttle *Challenger*, and technical malfunctions on a series of high-profile probes. Some can be traced to broader forces related to the popular culture of space.

Any substantial gap between beliefs and reality creates cognitive dissonance (knowledge inconsistencies).[38] A political program suffering the effects of cognitive dissonance is more likely to find itself buffeted by political turbulence than one that is not. For space, the gap between beliefs and reality arose because of the difficulty of building support for an ambitious exploration program. In spite of the early efforts of fiction writers and rocket pioneers, the lure of discovery and adventure was not sufficient to release the high level of public spending required to achieve their long-range goals. Discovery and adventure were sufficient to produce a space program along the lines of the Eisenhower alternative, but not the Kennedy program. Linking the exploration message to public anxiety about the Cold War allowed space boosters to unlock the public treasury and win public support for the more ambitious mission. Subsequently, the anxiety disappeared. The idea that world leadership depended upon a space program second to none lost much of its fashionableness among the public at large. The resulting political turbulence exasperated the difficulties normally encountered in prosecuting a high-technology space program.

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[37] See Leon Festinger, *When Prophecy Fails* (Minneapolis: University of Minneapolis Press, 1956).

[38] Leon Festinger, *A Theory of Cognitive Dissonance* (Stanford, CA: Stanford University Press, 1957).

Chapter 3

The Eisenhower Administration and the Cold War: Framing American Astronautics to Serve National Security

R. Cargill Hall[1]

In 1991 the Soviet Union, like the Berlin Wall before it, suddenly and unexpectedly was pulled down, replaced by a much weaker Commonwealth of Independent States. The Cold War abruptly ended. After forty-five years of uneasy nuclear stalemate and the ever present threat of an end to "modern civilization," the United States of America entered a new and uncertain era. If the United States and its western Allies emerged triumphant in this prolonged contest with communist ideology and its planned economy, they owed that triumph in large measure to a single American military and political leader.

With the loss of populous China to communism in 1949 and the surprise attack against South Korea in 1950, American leaders perceived the Soviet Union to be rapidly expanding its influence, intent on ensuring its ideology prevailed around the world. To counter the extraordinary military and political threats that that country posed, between 1953 and 1961, Dwight David Eisenhower and his lieutenants began seeking international agreements to ban, or at least limit with confidence, nuclear tests and nuclear weapons that might be supervised with on-site or overflight inspection. At the same time, they selected and approved for development vital new intercontinental weapon

[1] R. Cargill Hall is historian and chief of the Contract Histories Program at the Air Force History Support Office in Washington D.C. An Air Force historian since 1977, he was historian of NASA's Jet Propulsion Laboratory between 1967 and and 1977. He is the editor of *Lightning Over Bougainville: The Yamamoto Mission Reconsidered* (Smithsonian Institution Press, 1991), and author of *Lunar Impact: A History of Project Ranger* (NASA SP-4210, 1977). This chapter is part of a larger history of U.S. satellite reconnsaissance.

Figure 1 President Dwight D. Eisenhower during a radio and television address to the American public from the White House on July 25, 1955. Photograph from the National Archives and Records Administration, Washington, DC.

systems, they reordered United States military strategy, they revised mightily the country's intelligence apparatus, and they encouraged studies and established new organizations for purveying propaganda behind the Iron Curtain.[2] Finally, and perhaps ultimately most crucial to this agenda, they fashioned the national policy and framed all of the organizations needed to guide and execute a new enterprise called astronautics. This last set of actions, as their authors intended and as the Cold War transpired, contributed enormously to the nation's security and the maintenance of a delicate peace with the Soviet Union.

The Cold War and American Astronautics

Because the "space age" began amidst the superpower tensions of the 1950s, the tone, tempo, and direction of America's astronautical enterprise would be impressed with a near-indelible Cold War seal. (Indeed, so indelible was it when the Cold War ended that NASA and other Eisenhower-fashioned space organizations in the 1990s would grapple internally to change that seal and revalidate their reason for existence!) Nevertheless, on assuming the presidency in January 1953, Eisenhower doubtless knew little-to-nothing about astronautics. By all accounts, his attention riveted on ending the Korean war, on ways to forestall or counter a Soviet surprise attack on the United States, and on international agreements to reduce the construction and testing of nuclear weapons. Beside these immediate concerns and an unusual commitment to duty and country, basic perceptions and values also shaped this man and the outlook he brought with him to the Oval Office; they, too, affected profoundly the way American astronautics and space policy would unfold.

A fiscal conservative, Eisenhower believed the nation had to avoid mindless military expenditures to thwart every possible communist contingency. America, he was sure, could not survive as a democracy and as "a garrison state." Furthermore, should fearmongers provoke a movement toward the latter outcome, he worried the country would spend enormous sums on credit, mortgage its existence to defeat communism, and, by so doing, perhaps win the battle but ultimately lose the struggle. As a West Point graduate, career officer, and Supreme Commander of Allied Expeditionary Forces in Europe during World War II, Eisenhower well understood the military and its parochial interests. He also knew that the appropriate level of military preparedness needed to combat a specific threat could only be determined with certainty through first class

[2] The latter issue claimed immediate attention. In 1953 Eisenhower removed the International Information Administration from the Department of State and reorganized it as the U.S. Information Agency, and he combined the functions of President Truman's Psychological Strategy Board and Psychological Operations Coordinating Committee into a single new entity with the innocuous name, Operations Coordinating Board (OCB). Chaired by a ranking state department official, the OCB reported to the National Security Council. Its September 2, 1953, charter charged the OCB with coordinating all "overseas information and psychological warfare activities" of the U.S. government. See Rip Bulkeley, "Response to the Paper by Fred I. Greenstein and David Callahan," 1993 (unpublished), p. 2, copy in author's possession.

intelligence.[3] The new president had been privy to just that kind of wartime intelligence made possible through aerial reconnaissance and ULTRA radio communication intercepts and decryption. The black ULTRA effort and its product, known only to a select few Allied commanders, in the 1950s still remained among the darkest of wartime secrets. (It would not even become public knowledge for another twenty years, until the 1970s.) In executing key elements of the administration's agenda, Eisenhower and his advisors would adopt similar compartmented wartime security procedures: once again in the 1950s only a select few Americans, those who absolutely had to be informed, would be "witting" of the entire enterprise.[4]

In developing the most advanced technology for defense and intelligence programs needed to counter the Soviet threat, President Eisenhower relied heavily on the counsel of important advisors. They were Donald A. Quarles, his Assistant Secretary of Defense for Research and Development (later Secretary of the Air Force and Deputy Secretary of Defense), James R. Killian, President of MIT (later his science advisor), Edwin H. Land, inventor of the Polaroid instant camera, William O. Baker, Bell Laboratories research chemist, Edward M. Purcell, Harvard atomic physicist and Nobel laureate, James G. Baker, Harvard physicist and optics specialist, and George B. Kistiakowsky, Harvard chemist. These men, a few other scientists on presidential boards, and the Dulles brothers at state and CIA among other cabinet officers, appear to have been the principals in whom the president confided and who shared knowledge of the most tightly controlled programs. Among these programs: operation of the National Indications Center and National Watch Committee as described by Cynthia Grabo,[5] goals of the Operations Coordinating Board responsible for psychological warfare, and activities and recommendations of the Surprise Attack Panel, or Technological Capabilities Panel (TCP) as it was subsequently known, chaired by Killian—all of these activities established in 1953 and 1954.

Din Land led the TCP's Project 3 Intelligence Group. It consisted of six members including Land and focused on breaching the wall of secrecy that perhaps veiled Soviet preparations for an atomic surprise attack on the United States. In November 1954 Land and Killian conferred with President Eisenhower and secured his approval to build the turbojet-powered U-2 reconnaissance sailplane that could fly at extreme altitudes, even

[3] In a frequently-quoted statement describing the value of aerial reconnaissance to an accurate national intelligence assessment, Eisenhower declared "without it you would have only your fears on which to plan your own defense arrangements and your whole military establishment. Now if you're going to use nothing but fear and that's all you have, you are going to make us an armed camp. So this kind of knowledge is vital to us."

[4] See especially, F. H. Hinsley, E. E. Thomas, C. F. G. Ransom, and R. C. Knight, *British Intelligence in the Second World War: Its Influence on Strategy and Operations*, Vols II and III (New York: Cambridge University Press, 1981); Ralph F. Bennett, *Ultra in the West: The Normandy Campaign of 1944-1945* (New York: Scribner, 1980); and Stephen E. Ambrose, *Ike's Spies: Eisenhower and the Espionage Establishment* (Garden City, NY: Doubleday & Co., 1981).

[5] Cynthia M. Grabo, "The Watch Committee and the National Indications Center: The Evolution of U.S. Strategic Warning," *International Journal of Intelligence and CounterIntelligence*, Vol 3, No 3, Fall 1989.

Figure 2 Donald A. Quarles (Right) is sworn in as Secretary of the Air Force on August 15, 1955. Secretary of the Army Wilber M. Brucker administers the oath of office while Secretary of Defense Charles E. Wilson looks on. Photograph from the National Archives and Record Administration, Washington, DC.

though, in international law, national sovereignty obtained in the airspace above each nation.[6] Violating that legal principle in overflights of Soviet territory threatened the gravest of consequences should a U-2 ever be detected and shot down. The two-volume

[6] Land insisted that any committee which he chaired would be no larger than the number of persons able to fit inside a taxicab. An incredible collection of intellects, Project 3 members included Land, James Baker (designer of the B-2 aerial camera that, when captured with Francis Gary Powers, so dismayed Soviet leaders), John Tukey (co-author of the Cooley-Tukey Algorithm for fast Fourier Transforms, essential to virtually all subsequent advances in the world of electronics), Edward M. Purcell, nuclear physicist and Nobel laureate, Joseph W. Kennedy of Washington University in St. Louis, the chemist responsible for isolating plutonium, and Allan Latham, Jr., a founder of the Polaroid Corporation, now of the Arthur D. Little Co. Allen Donovan of Cornell Aeronautical Laboratory, who identified the three aircraft design axioms indispensible for flight at extremely high altitudes, also attended most of the Project meetings and became, in effect, a member *Ex Officio*. Of the three groups that made up the TCP, Land's was the smallest; soon known as the "Land Panel," it was, to be sure, also called the "Taxicab Committee." Reflections of Judge William H. Webster, DCI, in "Award Presentation" to Edwin H. Land, *Colloquy*, 9, July 1988, pp. 7-8. See also Leonard Mosley, *Dulles: A Biography of Eleanor, Allen, and John Foster Dulles and Their Family Network* (New York: Dial Press, 1978), pp. 365-66.

TCP final report issued in February 1955 thus contained not a word about the U-2. That black program, as Karl Harr later observed, did not even appear as an agenda item in National Security Council deliberations until it "tore its britches" in 1960.[7] The intelligence section of the TCP final report did recommend beginning a scientific Earth satellite project that might establish the principle of "freedom of space" in international law and the right of overflight in that new domain "above" a nation's airspace.

The genesis of America's military and civil space programs that sprang up during the Eisenhower Administration is well known. The relationship of these programs to the administration's efforts at "opening up" the Soviet Union, using technology that would keep this nation safe from a sneak atomic attack, is little known. Because of contemporary ULTRA-like security restrictions, it still is not entirely understood, but the general outline is now declassified and has begun to appear in the open literature. Based primarily on studies contracted with The RAND Corporation, the United States Air Force in early 1955 solicited from industry proposals to design and build a collection of related military satellites, among them reconnaissance vehicles. Other American scientists and engineers, meanwhile, proposed building and launching Earth satellites as part of the United States contribution to the International Geophysical Year (IGY), planned by the International Council of Scientific Unions to take place in 1957-1958.

In early 1955 all of the scientific satellite proposals landed by design on the desk of the Assistant Secretary of Defense for R&D, Donald Quarles. Aware of the U-2 program and convinced that the TCP report's freedom of space thesis was crucial for the future of intelligence, Quarles in late February privately urged the U.S. National Committee for the IGY in the National Academy of Sciences to request formally a scientific satellite project, which it did.[8] That request, made by a non-governmental scientific group, passed through the director of the National Science Foundation, then, as intended, back to Quarles for review in the Defense Department. In April the Assistant Secretary referred all of the IGY scientific satellite proposals to his Committee on Special Capabilities and asked that it recommend a preferred project. During Quarles' absence from Washington in early May, but apparently with his approval, director of the National Science Foundation Alan Waterman met with the director of the Central Intelligence Agency (DCI) Allen Dulles and U-2 project director Richard Bissell to discuss how best to proceed with "this item [previously] presented to the National Security Council in the Killian [TCP] Report, which has been transferred to the Department of Defense for comment."[9] On his return, Quarles acted on their advice. On May 20 he submitted

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[7] Karl G. Harr, Jr., "Eisenhower's Approach to National Security Decision Making," in Kenneth W. Thompson, ed., *The Eisenhower Presidency: Eleven Intimate Perspectives of Dwight D. Eisenhower* (Lanham, MD: University Press of America, 1984), p. 97.

[8] Memorandum of Alan T. Waterman, Director, National Science Foundation, to Robert Murphy, Deputy Under Secretary of State, March 18, 1955 (declassified November 15, 1989), NSC Staff Papers, OCB Central Files [11], OCB 000.91 #1 (2), Dwight D. Eisenhower Library, Abilene, KS.

[9] Alan T. Waterman, Director, National Science Foundation, to Assistant Secretary of Defense Donald A. Quarles, May 13, 1955 (declassified November 15, 1989), NSC Staff Papers, OCB Central Files [11], OCB 000.91 #1 (2), Eisenhower Library.

directly to the National Security Council a proposal for launching an IGY satellite and the national policy to guide this activity. Meeting on May 26, the NSC endorsed Quarles' recommendation for an IGY scientific satellite project, a recommendation that emphasized the peaceful purposes of the endeavor, one intended to establish the principle in international law of "freedom of space" and the right of unimpeded overflight that went with it. Next day, "after sleeping on it," Eisenhower approved this project and the proposed space policy.[10]

A few weeks later on July 21, 1955, with the first test flight of a U-2 near at hand, President Eisenhower broached a new disarmament proposal at the four-power summit conference in Geneva, Switzerland. Prepared by Eisenhower's Special Assistant Harold Stassen, the proposal incorporated the arms control concepts of Richard S. Leghorn. It called on each superpower to provide facilities for aerial photography to the other country and conduct mutually supervised reconnaissance overflights in each nation's airspace.[11] Eventually known as the "Open Skies Doctrine" after Eisenhower proposed this novel approach for eliminating fear of surprise attacks,[12] it was summarily rejected by the Soviet leadership as an obvious ploy to acquire targeting data. Back in the United States a few days later, on July 29, the president publicly announced plans for launching "small unmanned, Earth circling satellites as part of the U.S. participation in the International Geophysical Year." In assigning to the National Science Foundation responsibility for directing the project, his statement avoided any mention of its underlying, covert purpose.[13]

In the Department of Defense, Quarles' Committee on Special Capabilities completed its evaluation of scientific Earth satellites and in early August 1955 recommended the Navy proposal, known as Vanguard, instead of the Army's Orbiter proposal that featured as the launcher a military booster rocket. Approved by the defense department policy council, America's now-official IGY satellite project publicly claimed two primary objectives: to place at least one satellite in orbit around the Earth during the IGY,

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[10] National Security Council 5520, "U.S. Scientific Satellite Program," May 20, 1955, in John P. Glennon, ed., *Foreign Relation of the United States, 1955-1957: Volume XI, United Nations and General International Matters* (Washington DC: Government Printing Office, 1988), pp. 723-33. OCB members, including its chairman Herbert Hoover, Jr., were heavily involved in these deliberations and in the July 1955 public announcement of an IGY satellite program. See Bulkeley, "Response," p. 3.

[11] Cf., Richard S. Leghorn, "U.S. Can Photograph Russia from the Air Now," *U.S. News & World Report*, August 5, 1955, pp. 70-75; and "Editor's Note" at p. 71. This important article explained the administration's rationale for Open Skies and the implications of this plan for arms reduction. The significance of Richard Leghorn to USAF aerial reconnaissance is described in Donald Welzenbach, "The Anglo-American Origins of Overflying the Soviet Union: The Case of the 'Invisible Aircraft'," in Roger Miller, ed., *Anglo-American Air Power Cooperation During the Cold War: Proceedings of the 1993 Air Power History Symposium* (Washington, D.C.: Center for Air Force History, 1995).

[12] Text in "Statement on Disarmament, July 21," *The Department of State Bulletin*, 33 (August 1, 1955): 174.

[13] This news release reprinted in John P. Glennon, ed., *Foreign Relations of the United States, 1955-1957: Volume XX, Regulation of Armaments; Atomic Energy* (Washington, DC: Government Printing Office, 1990), p. 734.

Figure 3 President Dwight D. Eisenhower meets with the individual most responsible for drafting the "Open Skies" proposal, Special Assistant Harold Stasson, in the Oval Office on March 22, 1955. Photograph from the National Archives and Records Administration, Washington, DC.

and accomplish one scientific experiment. Though aware of expressed Soviet intentions also to launch an Earth satellite during the IGY and of the potential ill effects of being the second power into space, Administration leaders made no serious efforts in the months that followed to alter the priority assigned the Vanguard Project or accelerate it in a "race" for space with the Soviets. Indeed, no significant changes were made in Vanguard funding or schedules even in the summer of 1957 when DCI Allen Dulles advised Quarles that the Soviets probably would launch a satellite before the end of the year.[14]

This apparent failure to change the course of America's IGY satellite project after receiving advance warning of Soviet astronautical efforts has prompted considerable speculation in recent years. At a meeting not long ago John Logsdon reflected, "perhaps

[14] Allen W. Dulles, Director, Central Intelligence Agency, to Donald A. Quarles, Deputy Secretary of Defense, July 5, 1957. For a discussion of the decision in favor of Vanguard, see R. Cargill Hall, "Origins and Early Development of the Vanguard and Explorer Satellite Programs," *Airpower Historian* 9 (October 1964).

it was Eisenhower's intention all along that the Soviets be first into space!" One cannot rule this out, but all of the available evidence suggests administration leaders, though dismayed at the rising costs of Vanguard, remained unconcerned whether the Soviets did indeed launch the first satellite. The OCD had even prepared a congratulatory news release for Detlev Bronk, President of the National Academy of Sciences, to be read in that event, apparently misjudging grievously the blow to national pride that would result from it and the public outcry that would surely follow.[15] We do know with certainty that Donald Quarles, while subsequently serving as Secretary of the Air Force, withheld spending on the Air Force military satellite program for anything except design work, and that the defense department by 1957 expressly prohibited all American military leaders from discussing publicly military space activity. This last restriction imposed on those "unwitting" of the true purpose of the IGY satellite program subsequently led to some inflammatory Congressional testimony and bitter comments about Eisenhower and American defense preparedness in published memoirs. Clearly, the administration intended that a scientific satellite, not a military satellite, be the first man-made object to orbit the Earth, and that intemperate military members not provoke a world-wide debate on military space flight and thereby jeopardize prospects for international acceptance of the principle "freedom of space."

The first U-2 flight over the Soviet Union occurred on July 4, 1956, exactly fifteen months before the launch of Sputnik 1 on October 4, 1957.[16] By the time of the world's first satellite launch, Eisenhower presumably had obtained enough intelligence information to know that the so-called "bomber gap" did not exist and, at a later date, that the Soviet Union did not command numerous intercontinental ballistic missiles.[17] Unquestionably, he was nonplussed at the public reaction to Sputnik and did his best to reassure Americans that the country was not at risk militarily or in the fields of technology and education. But having already denied aerial overflights in response to Soviet protests,[18] and whatever the national outcry, in late 1957 he could not betray the source of his own

[15] Bulkeley, author of *The Sputnik Crisis and Early United States Space Policy* (Bloomington: Indiana University Press, 1991), is fascinated by Eisenhower's apparent failure to foresee the psychological impact of the Sputniks given the president's obvious interest in psychological warfare. Carried to the extreme, the logical conclusion is the one posited by Logsdon, but to date no documentary evidence has surfaced that would support so radical a notion.

[16] Michael R. Beschloss, *Mayday: The U-2 Affair* (New York: Perennial Library, 1987), p. 121.

[17] Peter C. Wensberg, *Land's Polaroid: A Company and the Man Who Invented It* (Boston: Houghton Mifflin Company, 1987), Chapter 15, "U-2," pp. 109-113. Technical details of the U-2 are garbled, but Wensberg was an officer at Polaroid and worked with Land; one may presume that his account of what Eisenhower knew is based on discussions with Land after the U-2 was shot down and became public knowledge. Indeed, in his last book, James Killian, too, acknowledged as much. "I will always remember . . . when George Kistiakowsky and I were presenting to the president U-2 photographs that gave him direct evidence of the status of the Soviet missile program *and proved there was no missile gap*." James R. Killian, *The Education of A College President: A Memoir* (Cambridge: The MIT Press, 1985), p. 456 (emphasis added).

[18] See July 9, 1956, Soviet communication protesting unauthorized U.S. overflight, and July 10, 1956, U.S. response, in *Department of State Bulletin*, July 30, 1956, p. 191.

confidence without inviting all of the international repercussions later visited on him when a U-2 was shot down. Nevertheless, not one single nation protested the overflight in outer space of Sputnik 1 or its November successor, Sputnik 2. And so enthused were they with their incredible propaganda coup, Soviet leaders at that *moment* neither differentiated between scientific or military satellites, nor qualified future flights of these vehicles; they unintentionally collaborated in establishing the precedent "freedom of space" that the President and his advisers quietly sought, a principle accepted by the United Nations by the end of 1958 and firmly established through custom in international law by the time Eisenhower left office in 1961.

Figure 4 A November 30, 1956 meeting of the senior scientific and technical leaders to receive the USAF Exceptional Service Award. Left to right: Air Force Secretary Donald A. Quarles; Harry Wexler, US Weather Bureau; George E. Valley, Jr., Lincoln Laboratories, MIT; Gen. Nathan F. Twining, USAF Chief of Staff; Lt. Gen. Donald Putt, USAF Deputy Chief of Staff, Research and Development; and retired Lt. Gen. James H. Doolittle. Photograph from the National Archives and Records Administration.

Space Program Organization and the Cold War

The Pearl Harbor effect of the Soviet space feats on American public opinion prompted from the Administration a variety of measures. On November 7, 1957, the president announced creation of a new post, Special Assistant for Science and Technology, and appointed to it long-time confidant James R. Killian. Now brought formally into government service, Killian chaired the newly-formed President's Science Advisory Committee (PSAC); thereafter he exerted enormous influence on the manner in which the American space program was structured and conducted. Next day, Secretary of Defense Neil McElroy authorized the Army to launch a scientific satellite using its Jupiter military missile, backing up the struggling National Science Foundation Vanguard Project. And in February 1958 the administration established the Advanced Research Projects Agency (ARPA) in the Department of Defense, responsible for initial military research and development before passing it to one of the services. Pending establishment of a national space agency, ARPA also gained temporary responsibility for managing all of the nation's civil scientific and military space projects.

At the White House, discussions of how best to fashion a national space agency began in earnest in February 1958. With his own interests focused on national security space applications, President Eisenhower was inclined at first to assign all American space endeavors to ARPA in the Department of Defense. Because of the need to emphasize the peaceful uses of space, expectations that the scientific exploration of space would receive much less attention in the Defense Department, and the importance of conducting America's space program primarily in the open, Killian persuaded Eisenhower that a civilian agency was the better choice.[19] As it turned out, the National Advisory Committee for Aeronautics, or NACA, was selected as the nucleus upon which to build, and the task of drafting the legislation fell to NACA General Counsel Paul G. Dembling. Endorsed by Killian and Eisenhower, and submitted to Congress on April 2, 1958, the measure passed essentially as first drawn, with the addition of a National Space Council containing a permanent staff perhaps the most notable change. Except for military space flight, for which the Department of Defense remained responsible, the National Aeronautics and Space Act declared that all non-military aeronautical and space endeavors sponsored by the United States would be directed by a civilian agency guided by eight objectives. First among them was basic scientific research. Signed into law by President Eisenhower on July 29, the act wrote a broad and comprehensive mandate for the peaceful pursuit of new knowledge and accompanying technology in space.

This act, which created NASA, divided American space activities between civilian space science and applications missions, and military defense support missions for which the Air Force eventually became the lead service. Among the defense support satellite applications were to be found those of navigation, communication, reconnais-

[19] Robert A. Divine, *The Sputnik Challenge: Eisenhower's Response to the Soviet Satellite* (New York: Oxford University Press, 1993), pp. 101-105. For another accounting, one in which Eisenhower does not act but is acted upon, see Glen P. Wilson, "Lyndon Johnson and the Legislative Origins of NASA," *Prologue: Quarterly of the National Archives* 25 (Winter 1993): 363-73.

sance, and missile early warning. To guide these astronautical activities after 1958, the administration amplified the tentative space policy fashioned in May 1955. Beside setting goals for civil and military astronautical activity, national space policy as proposed in June 1958 and as adopted and modified in August 1958 and January 1960, identified reconnaissance satellites "as a means of implementing the 'Open Skies' proposal or policing a system of international armaments control."[20] But reconnaissance satellites, for all practical purposes, still remained in the hands of the military service that first proposed them, with the Strategic Air Command scheduled to direct the operational system. After a U-2 was shot down in the Soviet Union on May 1, 1960, the president ordered a thorough evaluation of this intelligence effort and its organization.

Formation of the NRO

Before leaving office in January 1961, President Eisenhower put the last organizational component in place. Judged a vital national asset, space reconnaissance was placed directly under the control of civilian authorities in the Defense Department. In late August 1960 the National Security Council recommended and the President approved formation of what would become known as the National Reconnaissance Office, or NRO, soon responsible for all of America's reconnaissance satellites.[21] Thus he completed the framing of American astronautics in a house of three wings—NASA, military, and reconnaissance—a division of effort that would be endorsed formally by his successors and remain in effect from that day to this. The space reconnaissance wing, it should be added, would make possible arms control and arms reduction treaties with verification. Bespeaking its significance, a few years after Eisenhower left office President Lyndon Johnson publicly described space reconnaissance as the most important and valuable of all American astronautical activities;[22] indeed, it would affect profoundly the way in which the Cold War played out.

Astronautics represented but one element in a complex of national security issues decided in the Eisenhower Administration. James Killian recalled how the president harnessed science and technology to help find solutions for them. Eisenhower, he observed, brought together America's best and brightest from a variety of scientific fields, and an interdisciplinary synthesis "took place in the Eisenhower staff when those individuals who served on the Technological Capabilities Panel, on the President's Board of Con-

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[20] National Security Council, NSC 5814, "Preliminary U.S. Policy on Outer Space," June 20, 1958, para 21; National Security Council, NSC 5814/1, "Preliminary U.S. Policy on Outer Space," August 18, 1958, para 21; and National Security Council, "U.S. Policy on Outer Space," January 26, 1960, apparently moved to para 18, but all mention of reconnaissance satellites deleted from unclassified copy. See also, R. Cargill Hall, "The Origins of U.S. Space Policy: Eisenhower, Open Skies, and Freedom of Space," *Colloquy*, Vol 14, No 3, December 1993.

[21] Bill Gertz, "The Secret Mission of NRO," *Air Force Magazine*, June 1993, p. 62.

[22] *U.S. News & World Report*, September 9, 1968, p. 2.

sultants on Foreign Intelligence Activities, and on PSAC provided this creative integration of which I speak." For example, he continued, the fact that

> William Baker, Edwin Land, and I were engaged concurrently in several of these groups made it possible to achieve an extraordinary synthesis of minds and ideas to aid the president in achieving his goals in shaping our defense and intelligence programs and policy. The fact that a number of us, including Baker, Land, Zacharias, Wiesner, Beckler, Kistiakowsky, and many others worked together with interdisciplinary congeniality made possible the success of such achievements as the Polaris, the acceleration of our intercontinental ballistic missile program, the U-2, new techniques of undersea warfare, and spectacular advancement in our reconnaissance capabilities. Coupled with this concert of minds, . . . the results generated could be brought directly to the president for his consideration. My ready access to President Eisenhower made it possible for me promptly to bring to him, and to open opportunities for others to bring to him, new and important technologies, concepts, and analyses that added to the strength of our nation.[23]

These actions and events belie the popular image Eisenhower chose to project as a politician and statesman.[24] A well-known military leader who helped engineer the destruction of the Axis powers in Europe during World War II, he devised ways of assaying and constraining another foreign menace while serving his country again as perhaps its most "stealthy" president. Dwight Eisenhower and a few confidants in the 1950s planned and executed a critical American defense agenda. In that effort they organized and pursued the new technology of astronautics in a manner that most favorably influenced international events and met the most pressing security needs of the United States in a protracted Cold War.[25]

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[23] Killian, *Education of a College President*, pp. 455-56. For some of the contributions and work of PSAC, see pp. 335-37.

[24] As the records are declassified, a reassessment of President Eisenhower's actual (versus publicly perceived) role in American history appears well underway. Divine's *Sputnik Challenge* (1993) is a case in point. In an October 1993 episode of the PBS television documentary *American Experience*, "Eisenhower," hosted by David McCullough, historians considered the marked difference between Eisenhower's awkward syntax frequently evident in his public appearences as president and his well-crafted written work to be found throughout his career (he wrote his own memoirs). Fred Greenstein recounted a discussion in the Oval Office between Press Secretary James Hagerty and the president during the international crisis over the islands of Quemoy and Matsu. Concerned about a forthcoming news conference, Hagerty warned his boss of potentially embarrassing questions likely from reporters regarding America's use of tactical nuclear weapons against communist Chinese forces.

[25] A prominent alteration in the size and shape of American civil astronautics did occur later. Although Eisenhower heartily disapproved, he could not control decisions in favor of an extensive manned space flight program, especially manned flight to the Moon. Selected by his successor John F. Kennedy and approved by Congress, Project Apollo would be prosecuted to best the Soviets in a major astronautical endeavor expressly for purposes of international prestige. Because manned flight to the Moon had no direct national security value, Eisenhower judged the effort unwise and its incredible cost unjustified.

Chapter 4

Early U.S. Civil Space Policy, NASA, and the Aspiration of Space Exploration

Roger D. Launius[1]

When future generations review the history of the twentieth century they will undoubtedly judge humanity's movement into space, with both machines and people, as one of its seminal developments. The course of the U.S. space program might have moved any of several different directions after World War II, but it took one that has characterized it ever after as a huge scientific and technological effort with piloted activities serving as the mainstay of the civil program. It also took one that was oriented toward accommodating the peculiar circumstances of American society in the post-war era. In every instance relative to the activities that came under the purview of NASA, a unique confluence of political necessity, personal commitment and activism, scientific and technological ability, economic prosperity, and public mood made possible the policy decisions required to carry out any space program, especially the generally aggressive one that has been so much a part of NASA's history.

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[1] Roger D. Launius is chief historian of the National Aeronautics and Space Administration, Washington, D.C. He is the author of articles on the history of aeronautics and space appearing in several journals, and has also written or edited twelve books, including *Joseph Smith III: Pragmatic Prophet* (University of Illinois Press, 1988); *Missouri Folk Heroes of the Nineteenth Century* (Independence Press, 1989); *Differing Visions: Dissenters in Mormon History* (University of Illinois Press, 1994); and *NASA: A History of the U.S. Civil Space Program* (Robert E. Krieger, Inc., 1994).

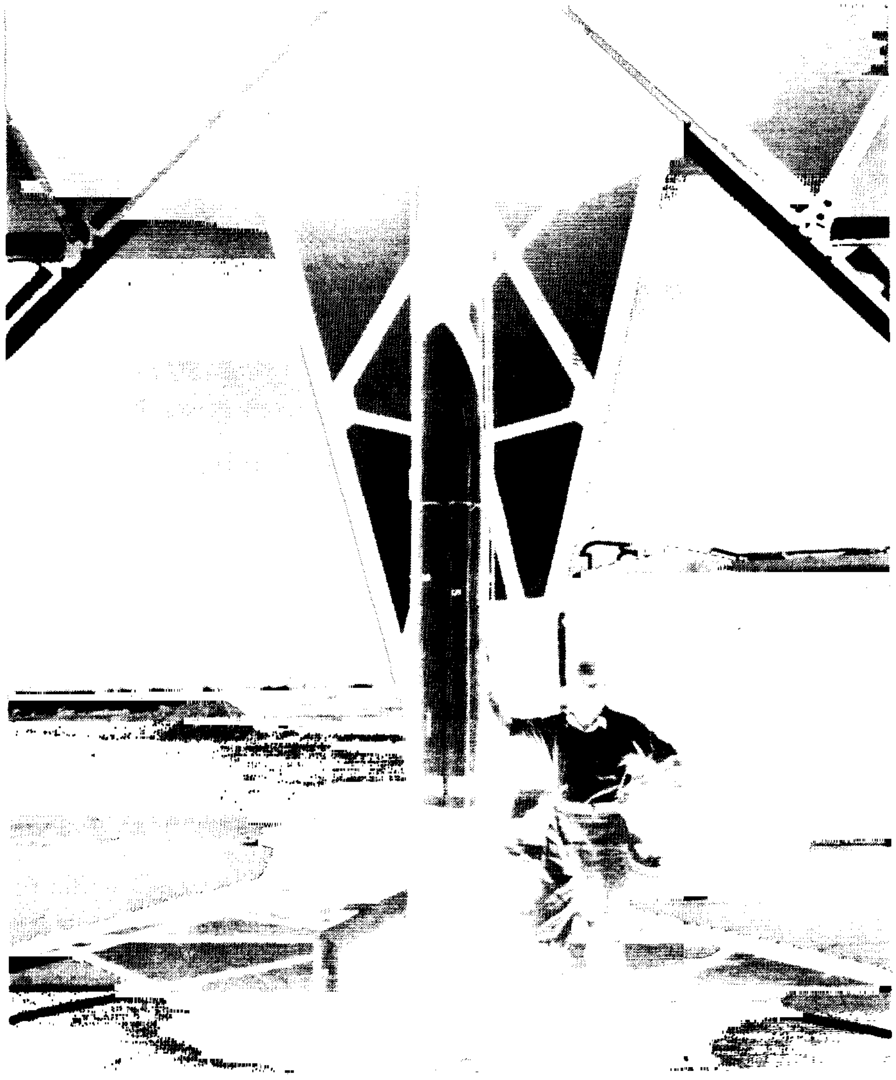

Figure 1 Frank J. Malina, the GALCIT/JPL rocketry expert, standing in 1945 beside the WAC Corporal rocket developed during World War II. Photograph from NASA collections, no. A5098-B.

The Rocket and Modern War

Although the work of prewar experimenters was pathbreaking, World War II truly altered the course of technological development making possible exploration of space. Prior to that conflict technological progress in rocketry had been erratic. The war, however, forced nations to focus attention on the activity and to fund research and development. Such research and development was oriented, of course, toward the advancement of rocket-borne weapons rather than rockets for space exploration and other peaceful purposes. This would remain the case even after the war, as competing nations perceived and supported advances in space technology largely because of their military potential and the national prestige associated with them. The security role of the Department of Defense and the function of NASA as a civilian space agency have been inextricably related ever since.

During World War II virtually every belligerent was involved in developing some type of rocket technology. For example, just before the entry of the United States into World War II, the nation's military began in earnest to acquire a rocket capability, and several efforts were aimed in that direction. One of the most significant was at the Guggenheim Aeronautical Laboratory, California Institute of Technology (GALCIT), renamed the Jet Propulsion Laboratory (JPL) in 1943, where Theodore von Kármán, Frank J. Malina, and a group of talented young engineers made important strides based on their research from the latter 1930s. They developed in 1941, for instance, the first jet-assisted take-off (JATO) solid-fuel rocket system.[2]

In March 1942 the GALCIT team that had developed the JATO system founded Aerojet Engineering Corporation as a vehicle for mass-producing and marketing this new technology; the new company quickly became one of the leading manufacturers of rockets in the United States. Malina recalled that the movement of scientists and engineers into business did not set well with the military. Within two months of creating Aerojet, von Kármán had brought in two big military production contracts for JATO systems, but the Army Air Forces—successor to the Army Air Corps—canceled its contract even before production began. Von Kármán and Malina flew to Washington, D.C., to protest the decision, and learned that conflict of interest concerns had prompted the cancellation. "We like you very much, doctor," Colonel Benjamin Chidlaw told von Kármán, "but only in cap and gown to advise us what to do in science. The derby hat of the businessman doesn't befit you." The leaders of Aerojet were able to overcome this problem only because of the dearth of rocket expertise in the United States, but it ceased to be a problem after 1944 when the General Tire and Rubber Company bought a controlling interest in Aerojet and divorced it from its JPL ties.[3]

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[2] Clayton L. Koppes, *JPL and the American Space Program: A History of the Jet Propulsion Laboratory* (New Haven: Yale University Press, 1982), pp. 11-16; Theodore von Kármán, with Lee Edson, *The Wind and Beyond: Theodore von Kármán, Pioneer in Aviation and Pathfinder in Space* (Boston: Little, Brown, 1967), pp. 244-56; Theodore von Kármán, "Jet Assisted Take-off," *Interavia*, July 1952, pp. 376-77.

[3] Von Kármán, with Edson, *Wind and Beyond*, p. 258-60; Frank J. Malina, "The U.S. Army Air Corps Jet Propulsion Research Project, GALCIT Project No. 1, 1939-1946: A Memoir," in R. Cargill Hall, ed., *Essays on the History of Rocketry and Astronautics: Proceedings of the Third through the Sixth History Symposia of the International Academy of Astronautics* (San Diego: Univelt, Inc., 1986), pp. 195-96; Michael H. Gorn, *The Universal Man: Theodore von Kármán's Life in Aeronautics* (Washington, DC: Smithsonian Institution Press, 1992), pp. 90-92; Koppes, *JPL and the American Space Program*, pp. 16-17.

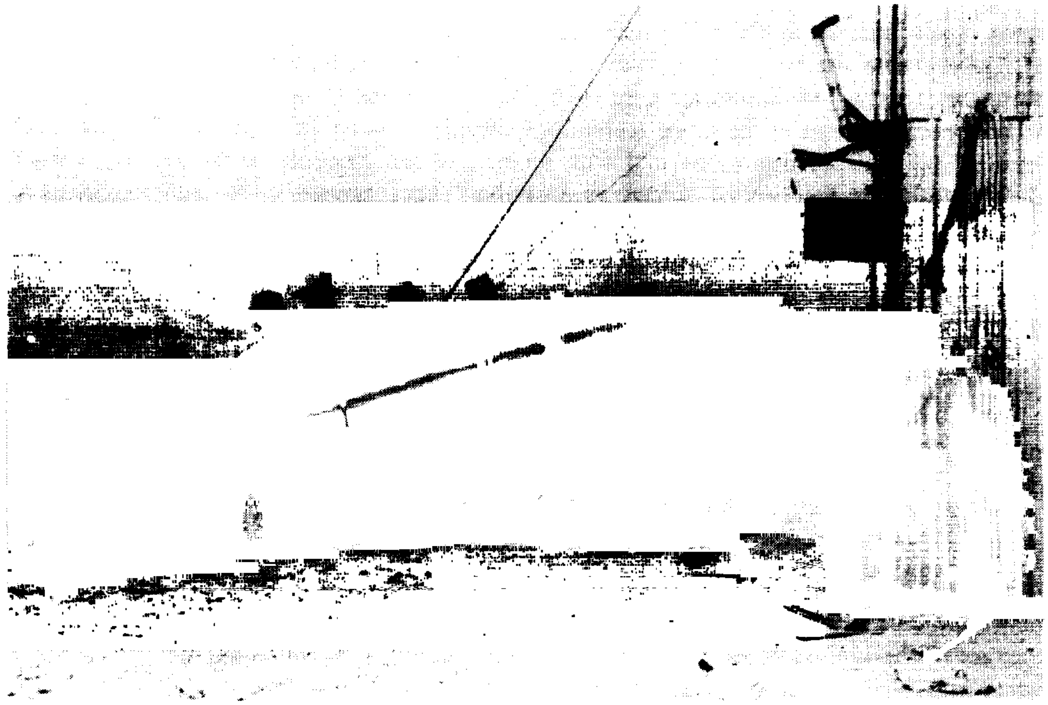

Figure 2 The recognized "pioneer" of American rocketry, Robert H. Goddard, conducted research for two decades before World War II. Here Goddard (second from right) is working with assistants to place a rocket used in an October 27, 1931, test on its stand. The test tower was located on a prairie ten miles northwest of Roswell, New Mexico. Photograph from NASA collections, no. 74-H-1195.

Even as these activities were taking place, in 1943 JPL engineers concluded in a report to the Army Air Forces that "the development of a long-range rocket projectile is within engineering feasibility" and asked for funding to bring it to a reality.[4] With some investment financing from the Army, JPL conducted research on engines and other components. Then on January 16, 1945, Malina sent to the Army Ordnance Section a proposal for a liquid-fuel "sounding" rocket that would be able to launch a 25-pound payload to an altitude of 100,000 feet. What emerged from these recommendations was a decision to develop the WAC Corporal, first flown on October 11, 1945; the WAC Corporal became a significant launch vehicle in postwar rocket research.[5]

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[4] Theodore von Kármán, "Memorandum on the Possibilities of Long-Range Rocket Projectiles," November 20, 1943, Frank J. Malina Folder, Biographical Files, NASA Historical Reference Collection, NASA History Office, NASA Headquarters, Washington, DC.

[5] Frank J. Malina, "America's First Long-Range-Missile and Space Exploration Program: The ORDCIT Project of the Jet Propulsion Laboratory, 1943-1946, a Memoir," in Hall, ed., *Essays on the History of Rocketry and Astronautics*, pp. 339-83; William R. Corliss, *NASA Sounding Rockets, 1958-1968: A Historical Summary* (Washington, DC: NASA SP-4401, 1971), pp. 17-18.

Less significant, but deserving of attention if only because it was the first U.S. corporation dedicated solely to the development of liquid rocket engines and accessory equipment, Reaction Motors, Inc. (RMI), came into being less than two weeks after the United States entered World War II. Based at Pompton Plains, New Jersey, its founders had been longtime rocket enthusiasts intimately connected with the American Interplanetary Society/American Rocket Society. All were convinced of the military and business potential of the rocket in the expanding world conflict. The company's leadership negotiated a contract with the Navy's Bureau of Aeronautics to develop a 445 Newton (100 lb) thrust regeneratively-cooled rocket motor, which was to be employed by the Navy to assist large, heavily-laden flying boats during takeoff. By the end of November 1943, RMI was heavily involved with naval research in Annapolis. There, a nitric acid-based rocket program was underway at the Naval Engineering Experiment Station where Robert H. Goddard was working on pumps and turbines. Goddard's work was put to good use by RMI, which by early 1944 had succeeded in testing a liquid-fueled engine mounted in a Navy PBM3C flying boat. The company then went on to develop the rocket engine that propelled the first piloted aircraft to fly faster than the speed of sound, the Air Force X-1 in 1947. Thereafter, RMI contributed critical engine components to virtually all U.S. rocket programs.[6]

Post-War Rocket Technology and Space Science

The influx into the United States of captured German technicians and V-2 rocket components at the end of World War II merged with native U.S. rocketry capabilities at JPL, RMI, and elsewhere to create a potentiality for spaceflight that was for the first time in the human record realizable. While captured German expertise and hardware represented something of a reparations exacted by the U.S. on Germany for the enormous destruction of the war, it fostered a unique confluence of ideas and expertise that brought the space age to dawning within a dozen years. U.S. researchers employed emigré Wernher von Braun, technical director of the German V-2 rocket program, and many of his chief German engineers, in a series of projects for the Department of Defense to further U.S. technical capability to gain access to space. Von Braun and company were installed at Fort Bliss in El Paso, Texas, and launch facilities for a V-2 test program were set up at the nearby White Sands Proving Ground in New Mexico. Later, in 1950 von Braun's band of over 100 people moved to the Redstone Arsenal near Huntsville, Alabama, to concentrate on the development of a new missile for the Army. Meantime, in Project Hermes, the first successful American test firing of the captured V-2s took

[6] James H. Wyld, "The Liquid Propellant Rocket Engine," *Mechanical Engineering*, June 1947, p. 5; Frederick I. Ordway III and Frank H. Winter, "Reaction Motors, Inc.: A Corporate History, 1941-1958," Parts I and II, in Roger D. Launius, ed., *History of Rocketry and Astronautics: Proceedings of the Fifteenth and Sixteenth Symposia of the International Academy of Astronautics* (San Diego: Univelt, Inc., 1994), pp. 75-100, 101-27.

place at White Sands on 16 April 1946. Between 1946 and 1951, 67 captured V-2s were test launched. The result was a significant expansion of U.S. knowledge of rocketry.[7]

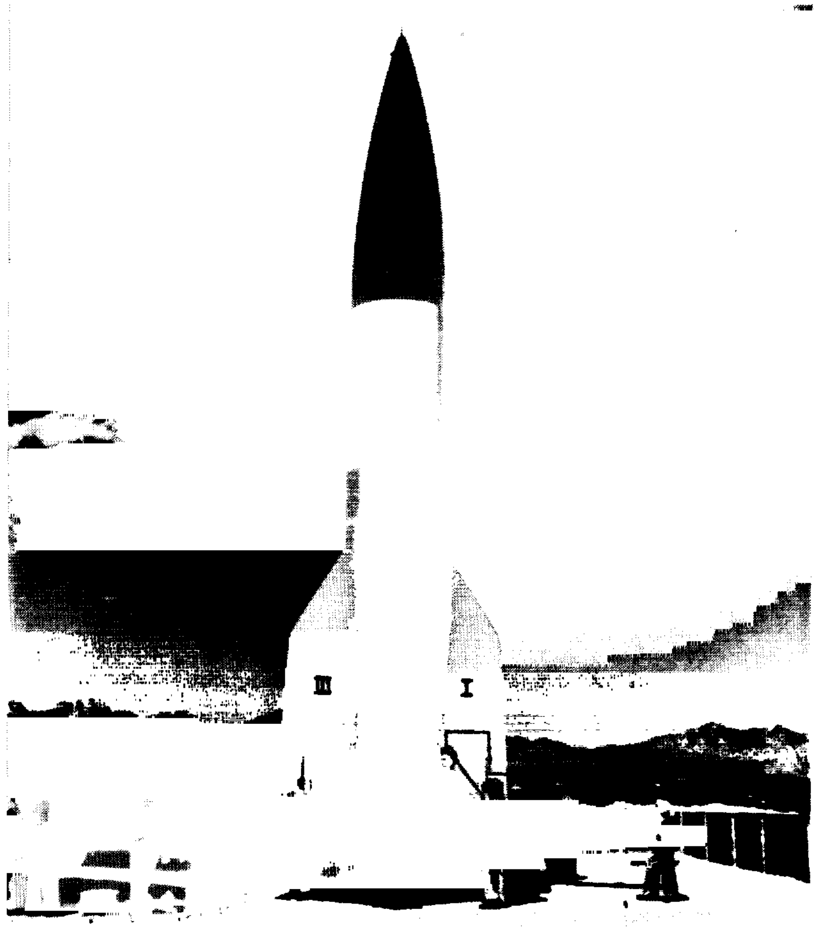

Figure 3 A captured V-2 rocket is being readied for flight at the U.S. Army's White Sands Proving Grounds, New Mexico, just after the end of World War II. Photograph from NASA collections.

[7] This effort has been discussed in James McGovern, *Crossbow and Overcast* (New York: William Morrow, 1964); Clarence G. Lasby, *Project Paperclip: German Scientists and the Cold War* (New York: Athenaeum, 1971); Frederick I. Ordway III and Mitchell R. Sharpe, *The Rocket Team* (New York: Crowell, 1979); Linda Hunt, *Secret Agenda: The United States Government, Nazi Scientists, and Project Paperclip,* 1945-1990 (New York: St. Martin's Press, 1991). On the rocketry tests at White Sands see Corliss, *NASA Sounding Rockets*, pp. 11-15; Homer E. Newell, *High Altitude Rocket Research* (New York: Academic Press, 1953); David H. DeVorkin, *Science with a Vengeance: How the Military Created the US Space Sciences After World War II* (New York: Springer-Verlag, 1992).

Although the U.S. Army was using these captured V-2 rockets to learn more about the technology, late in 1945 it offered scientists the opportunity to put experiments on them to study the upper atmosphere. Immediately thereafter the War Department established an Upper Atmosphere Research Panel, and although its name and scope of responsibilities changed periodically during the next several years it continued to coordinate these activities until the birth of NASA in 1958. It prioritized the use of these sounding rockets to study solar and stellar ultraviolet radiation, the aurora, and the nature of the upper atmosphere. As a result, the panel served as the "godfather" of the infant scientific field of space science. Scientific data, while desired, was not the primary purpose of these flights, for Army Ordnance was interested mostly in learning about rocketry to aid in the development of a more advanced generation of weapons.[8]

Throughout the late 1940s and early 1950s rocket technicians conducted ever more demanding test flights and scientists conducted increasingly more complex scientific investigations made possible by the rocket technology. One of the most important series of flights was Project Bumper, which utilized a smaller Army WAC Corporal missile, produced at JPL, as a second stage of a V-2 to obtain data on both high altitudes and the principles of two-stage rockets. The only fully successful launch took place on February 24, 1949, when the V-2/WAC Corporal system reached an altitude of 244 miles and a velocity of 5,150 miles per hour. Much more useful was the Aerobee, a scaled-up version of the WAC Corporal developed by JPL, which could launch at a very economical cost a sizable payload to an altitude of 130 miles. The reliable little booster enjoyed a long career from its first instrumented firing on November 24, 1947, until the January 17, 1985, launch of the 1,037th and last Aerobee. Additionally, the Naval Research Laboratory was involved in sounding rocket research, non-orbital instrument launches, using the Viking launch vehicle built by the Glenn L. Martin Company. Viking 1 was launched from White Sands on May 3, 1949, while the twelfth and last Viking took off on February 4, 1955. The program produced significant scientific information about the upper atmosphere and took impressive high-altitude photographs of Earth. Most important, the Viking pioneered the use of a gimballed engine to control flight and paved the way for later orbiting scientific satellites.[9]

In virtually every instance, rockets developed during the 1950s resulted from the adoption of a basic system built on components that had been tested earlier and mated together into a new booster. For instance, the Scout booster began in 1957 as an attempt by the National Advisory Committee for Aeronautics (NACA) to build a solid-fuel rocket that could launch a small scientific payload into orbit. To achieve this end, researchers investigated various solid-rocket configurations and finally decided to combine a Jupiter Senior (100,000 pounds of thrust), built by the Aerojet Corporation, with a second stage composed of a Sergeant missile base and two new upper stages descended from the research effort that produced the Vanguard. The Scout's four-stage booster could place a 330 pound satellite into orbit, and it quickly became a workhorse in orbit-

[8] John E. Naugle, *First Among Equals: The Selection of NASA Space Science Experiments* (Washington, DC: NASA SP-4215, 1991), pp. 1-4.

[9] David H. DeVorkin, *Science with a Vengeance*: (New York: Springer-Verlag, 1993), pp. 167-92.

ing small scientific payloads. It was first launched on July 1, 1960, and despite some early deficiencies, by the end of 1968 had achieved an 85 percent launch success rate.[10]

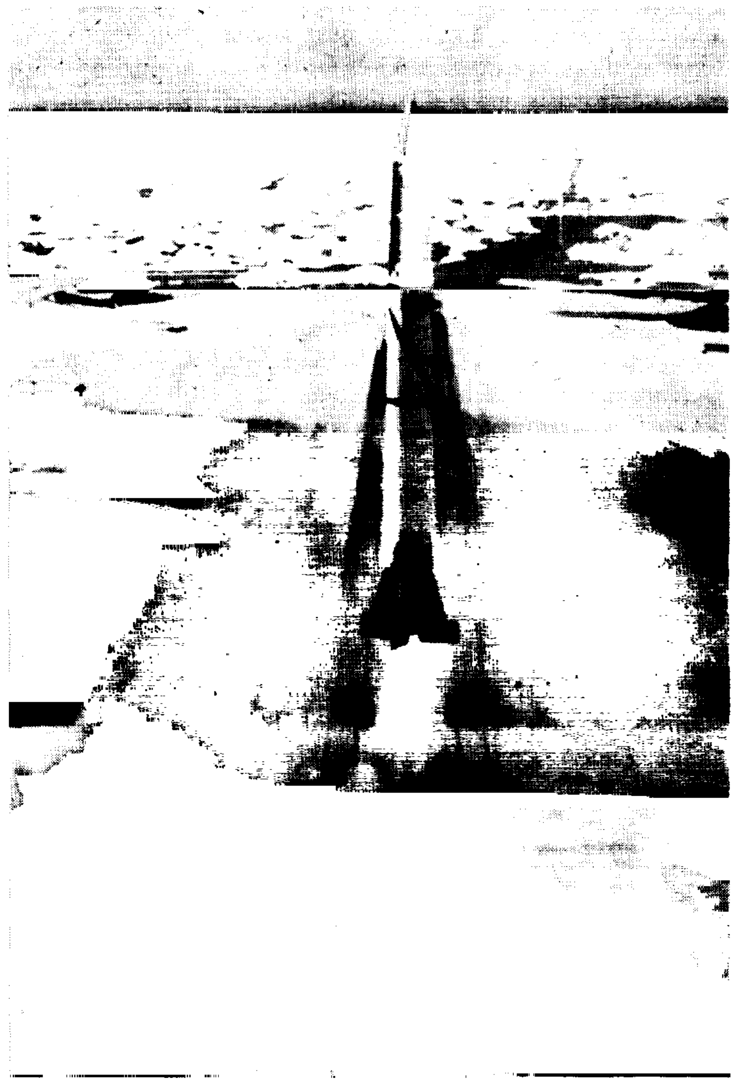

Figure 4 This Redstone is being launched for test purposes from the White Sands Proving Grounds in the 1950s. Photograph from NASA collections.

[10] Linda Neuman Ezell, *NASA Historical Data Book, Vol II: Programs and Projects, 1958-1968* (Washington, DC: NASA SP-4012, 1988), pp. 61-67; Richard P. Hallion, "The Development of American Launch Vehicles Since 1945," in Paul A. Hanle and Von Del Chamberlain, eds., *Space Science Comes of Age: Perspectives in the History of the Space Sciences* (Washington, DC: Smithsonian Institution Press, 1981), pp. 126-27.

The Army also developed the Redstone rocket during this same period, a missile capable of sending a small warhead a maximum of 500 miles. Built under the direction of von Braun and his German rocket team in the early 1950s, the Redstone took many features from the V-2, added an engine from the Navaho test missile, and incorporated some of the electronic components from other rocket test programs. The first Redstone was launched from Cape Canaveral, Florida, on August 20, 1953. An additional 36 Redstone launches took place through 1958. This rocket led to the development of the Jupiter C, an intermediate-range ballistic missile that could deliver a nuclear warhead to a target after a non-orbital flight through space. Its capability for this mission was tested on May 16, 1958, when combat-ready troops first fired the rocket. The missile was placed on active service with U.S. units in Germany the next month and served until 1963. The Redstone later served as the launch vehicle for the first U.S. suborbital launches of astronauts Alan B. Shepard and Gus Grissom in 1961.[11]

The Development of Ballistic Missiles

During this same era all the U.S. armed services worked toward the fielding of intercontinental ballistic missiles (ICBM) that could deliver warheads to targets half a world away. Competition was keen among the services for a mission in the new "high ground" of space, whose military importance was not lost on the leaders of the world. In April 1946 the Army Air Forces gave Consolidated Vultee Aircraft (Convair) Division a study contract for an ICBM. This led directly to the development of the Atlas ICBM in the 1950s. At first many engineers believed Atlas to be a high-risk proposition. To limit its weight, Convair Corp. engineers under the direction of Karel J. Bossart, a pre-World War II immigrant from Belgium, designed the booster with a very thin, internally pressurized fuselage instead of massive struts and a thick metal skin. The "steel balloon," as it was sometimes called, employed engineering techniques that ran counter to the conservative engineering approach used by Wernher von Braun and his "Rocket Team" at Huntsville, Alabama. Von Braun, according to Bossart, needlessly designed his boosters like "bridges," to withstand any possible shock. For his part, von Braun thought the Atlas was too flimsy to hold up during launch. The reservations began to melt away, however, when Bossart's team pressurized one of the boosters and dared one of von Braun's engineers to knock a hole in it with a sledge hammer. The blow left the booster unharmed, but the recoil from the hammer nearly clubbed the engineer.[12]

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[11] Wernher von Braun, "The Redstone, Jupiter, and Juno," in Eugene M. Emme, ed. *The History of Rocket Technology* (Detroit: Wayne State University Press, 1964), pp. 107-21.

[12] Richard E. Martin, *The Atlas and Centaur "Steel Balloon" Tanks: A Legacy of Karel Bossart* (San Diego: General Dynamics Corp., 1989); Robert L. Perry, "The Atlas, Thor, Titan, and Minuteman," in Emme, ed., *History of Rocket Technology*, pp. 143-55; John L. Sloop, *Liquid Hydrogen as a Propulsion Fuel, 1945-1959* (Washington, DC: NASA SP-4404, 1978), pp. 173-77.

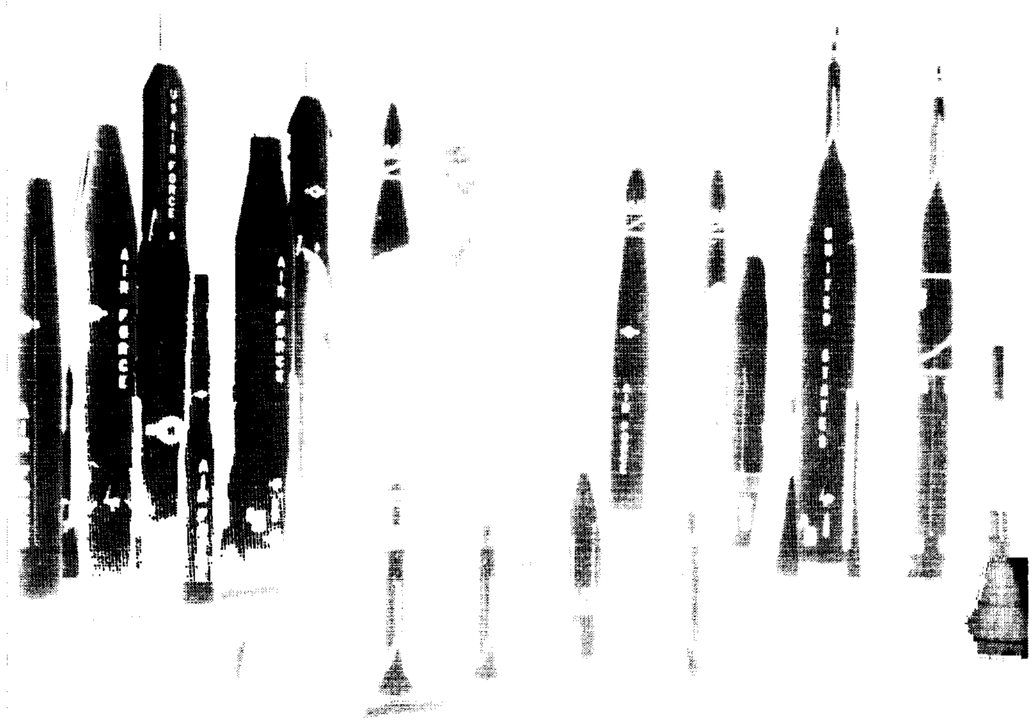

Figure 5 Lt. Gen. Bernard A. Schriever, one of the architects of the U.S. Air Force's ballistic missile force, in a 1960 publicity photograph. Schriever headed the Air Force ballistic missile organization in the 1950s before commanding the Air Force Systems Command in the 1960s. Photograph from USAF collections, no. 86828-60.

The Titan ICBM effort emerged not long thereafter, and proved to be an enormously important ICBM program and later a civil and military space launch asset. To consolidate efforts, Secretary of Defense Charles E. Wilson issued a decision on November 26, 1956, that effectively took the Army out of the ICBM business and assigned responsibility for land-based systems to the Air Force and sea-launched missiles to the Navy. The Navy immediately stepped up work for the development of the submarine-launched Polaris ICBM, which first successfully operated in January 1960.

The Air Force did the same with land-based ICBMs, and its efforts were already well-developed at the time of the 1956 decision. The Atlas received high priority from the White House and hard-driving management from Brigadier General Bernard A. Schriever, a flamboyant and intense Air Force leader. The first Atlas rocket was test fired on June 11, 1955, and a later generation rocket became operational in 1959. These systems were followed in quick succession by the Titan ICBM and the Thor intermediate-range ballistic missile. By the latter 1950s, therefore, rocket technology had developed sufficiently for the creation of a viable ballistic missile capability. This was a revolutionary development that gave humanity for the first time in its history the ability to attack one continent from another. It effectively shrank the size of the globe, and the United States—which had always before been protected from outside attack by two massive oceans—could no longer rely on natural defensive boundaries or distance from its enemies.[13]

Space and the American Imagination

The technological developments in rocketry, mostly for military purposes, were a necessary prelude to the development of a firm civil space policy in the latter part of the 1950s. Indeed, civil space policy is as much an outgrowth of these developments in rocketry for national defense purposes as any other reason. A central feature of the 1950s was that these technological developments were coupled with an American imagination for exploring the region beyond the Earth.[14] In the process, the dreams of science fiction aficionados were combined with developments in rocket technology to create the probability of a dawning space age. There was an especially significant space flight "imagination" that came to the fore after World War II and that urged the implementation of an aggressive space flight program. It was seen in science fiction books and film, but more importantly, it was fostered by serious and respected scientists, engineers, and politicians. The popular culture became imbued with the romance of space flight, and the practical developments in technology reinforced these perceptions that space travel might actually be, for the first time in human history, possible.[15]

The decade following the war brought a see change in perceptions, as most Americans went from skepticism about the probabilities of space flight to an acceptance of it as a near-term reality. This can be seen in the public opinion polls of the era. For instance, in December 1949 Gallup pollsters found that only fifteen percent of Americans believed humans would reach the Moon within 50 years, while fifteen percent had no opinion and a whopping 70 percent believed that it would not happen within that time. In October 1957, at the same time as the launching of Sputnik I, only 25 percent believed that it would take longer than 25 years for humanity to reach the Moon, while 41 percent believed firmly that it would happen within 25 years and 34 percent were not sure. An important shift in perceptions took place during that era, and it was largely the

[13] This story is told in Edmund Beard, *Developing the ICBM: A Study in Bureaucratic Politics* (New York: Columbia University Press, 1976); Jacob Neufeld, *Ballistic Missiles in the United States Air Force, 1945-1960* (Washington, DC: Office of Air Force History, 1990).

[14] Howard E. McCurdy has a major book project underway on this subject. His essay in this volume is a report of some of his findings.

[15] This is the thesis of William Sims Bainbridge, *The Spaceflight Revolution: A Sociological Study* (New York: Wiley, 1976). See also Willy Ley and Chesley Bonestell, *The Conquest of Space* (New York: Viking, 1949).

result of well-known advances in rocket technology coupled with a public relations campaign based on the real possibility of spaceflight.[16]

There were many ways in which the U.S. public became aware that flight into space was a possibility, ranging from science fiction literature and film that were more closely tied to reality than ever before[17] to speculations by science fiction writers about possibilities already real[18] to serious discussions of the subject in respected popular magazines. Among the most important serious efforts was that of the handsome German emigré, Wernher von Braun, working for the Army at Huntsville, Alabama. Von Braun, in addition to being a superbly effective technological entrepreneur, managed to seize powerful print and electronic communication outlets, and no one was a more effective promoter of space flight to the public during the decade.[19]

In 1952 von Braun burst on the broad public stage with a series of articles in *Collier's* magazine about the possibilities of spaceflight. The first issue of *Collier's* devoted to space appeared on March 22, 1952. In it readers were asked "What Are We Waiting For?" and were urged to support an aggressive space program. An editorial suggested that space flight was possible, not just science fiction, and that it was inevitable that humanity would venture outward. Von Braun led off the *Collier's* issue with an impressionistic article describing the overall features of an aggressive space flight program. He advocated the orbiting of an artificial satellite to learn more about space flight, followed by the first orbital flights by humans, development of a reusable spacecraft for travel to and from Earth orbit, building a permanently inhabited space station, and finally human exploration of the Moon and planets by spacecraft launched from the space station. Willy Ley and several other writers then followed with elaborations on various aspects of space flight ranging from technological viability to space law to biomedi-

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[16] George H. Gallup, *The Gallup Poll: Public Opinion, 1935-1971* (New York: Random House, 1972), 1:875, 1152.

[17] One of the keys in this process was the work of film producer-director George Pal, a master of special effects, who made several space-oriented movies in the 1950s. On Pal's career see, Gail Morgan Hickman, *The Films of George Pal* (South Berwick: A.S. Barnes, 1977); Robert A. Heinlein, "Shooting Destination Moon," *Astounding Science Fiction*, July 1950, p. 6. Especially memorable were two films, *The Day the Earth Stood Still* (1950), directed by Robert Wise, in which the benevolent alien Klaatu warns the Earth to shape up and control its aggressiveness by disarming, and *Forbidden Planet* (1956), about the extinct Krell superintelligent society and the Monster from the Id. These films excited the public with ideas of space flight, exploration, and contact with alien civilizations. It is often easy to forget that these sophisticated visions of space travel occurred before Sputnik.

[18] For example, science fiction writer Arthur C. Clarke described in February 1945 the use of the German V-2 as a launcher for ionospheric research, even as the war was going on. He specifically suggested that by putting a second stage on a V-2 the rocket could generate enough velocity to launch a small satellite into orbit. "Both of these developments demand nothing in the way of technical resources," he wrote, adding that they "should come within the next five or ten years." See, Arthur C. Clarke, "V2 for Ionospheric Research?" *Wireless World*, February 1945, p. 58.

[19] See as an example of his exceptionally sophisticated space flight promoting, Wernher von Braun, *The Mars Project* (Urbana: University of Illinois Press, 1953), based on a German-language series of articles appearing in the magazine *Weltraumfahrt* in 1952.

cine.[20] The series concluded with a special issue devoted to Mars, in which von Braun and others described how to get there and predicted what might be found based on recent scientific data.[21]

The *Collier's* series catapulted von Braun into the public spotlight like none of his previous activities had been able to do. The magazine was one of the four highest-circulation periodicals in the United States during the early 1950s, with over three million copies produced each week. If estimates of readership were indeed four or five people per copy, as the magazine claimed, something on the order of 15 million people were exposed to these space flight ideas. *Collier's*, seeing that it had a potential blockbuster, did its part by hyping the series with window ads of the space artwork appearing in the magazine, sending out more than 12,000 press releases, and preparing media kits. It set up interviews on radio and television for von Braun and the other space writers, but especially von Braun, whose natural charisma and enthusiasm for space flight translated well through that medium. Von Braun appeared on NBC's "Camel News Caravan" with John Cameron Swayze, on NBC's "Today" show with Dave Garroway, and on CBS's "Gary Moore" program. While *Collier's* was interested in selling magazines with these public appearances, von Braun was interested in selling the idea of space travel to the public.[22]

Following closely on the heels of the *Collier's* series, Walt Disney Productions contacted von Braun—through Willy Ley—and asked his assistance in the production of three shows for Disney's weekly television series. The first of these, "Man in Space," premiered on Disney's show on March 9, 1955, with an estimated audience of 42 million. The second show, "Man and the Moon," also aired in 1955 and sported the powerful image of a wheel-like space station as a launching point for a mission to the Moon. The final show, "Mars and Beyond," premiered on December 4, 1957, after the launching of Sputnik I. Von Braun appeared in all three films to explain his concepts for human space flight, while Disney's characteristic animation illustrated the basic principles and ideas with wit and humor.[23]

While some scientists and engineers criticized von Braun for his blatant promotion of both space flight and himself, the *Collier's* series of articles and especially the three Disney television programs were exceptionally important in changing public attitudes

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[20] "Man Will Conquer Space Soon" series, *Collier's*, March 22, 1952, pp. 23-76ff.

[21] Wernher von Braun with Cornelius Ryan, "Can We Get to Mars?" *Collier's*, April 30, 1954, pp. 22-28.

[22] Randy L. Liebermann, "The *Collier's* and Disney Series," in Frederick I. Ordway III and Randy L. Liebermann, *Blueprint for Space: From Science Fiction to Science Fact* (Washington, DC: Smithsonian Institution Press, 1992), p. 141; Ron Miller, "Days of Future Past," *Omni*, October 1986, pp. 76-81.

[23] Liebermann, "The *Collier's* and Disney Series," in Ordway and Liebermann, *Blueprint for Space*, pp. 144-46; David R. Smith, "They're Following Our Script: Walt Disney's Trip to Tomorrowland," *Future*, May 1978, pp. 59-60; Mike Wright, "The Disney-Von Braun Collaboration and Its Influence on Space Exploration," paper presented at conference, "Inner Space, Outer Space: Humanities, Technology, and the Postmodern World," February 12-14, 1993; Willy Ley, *Rockets, Missiles, and Space Travel* (New York: The Viking Press, 1961 ed.), p. 331.

toward space flight. Media observers noted the favorable response to the three Disney shows from the public, and recognized that "the thinking of the best scientific minds working on space projects today" went into them, "making the picture[s] more fact than fantasy."[24] Clearly the *Collier's* and Disney series helped to shape the public's perception of space flight as something that was no longer fantasy.

The coming together of public perceptions of space flight as a near-term reality with the technological developments then being seen at White Sands and elsewhere, created an environment much more conducive to the establishment of an aggressive space program. The convincing of the American public that space flight was possible was one of the most critical components of the space policy debate of the 1950s. For realizable public policy to emerge in a democracy, people must both recognize the issue in real terms and develop confidence in the attainability of the goal. It was present by

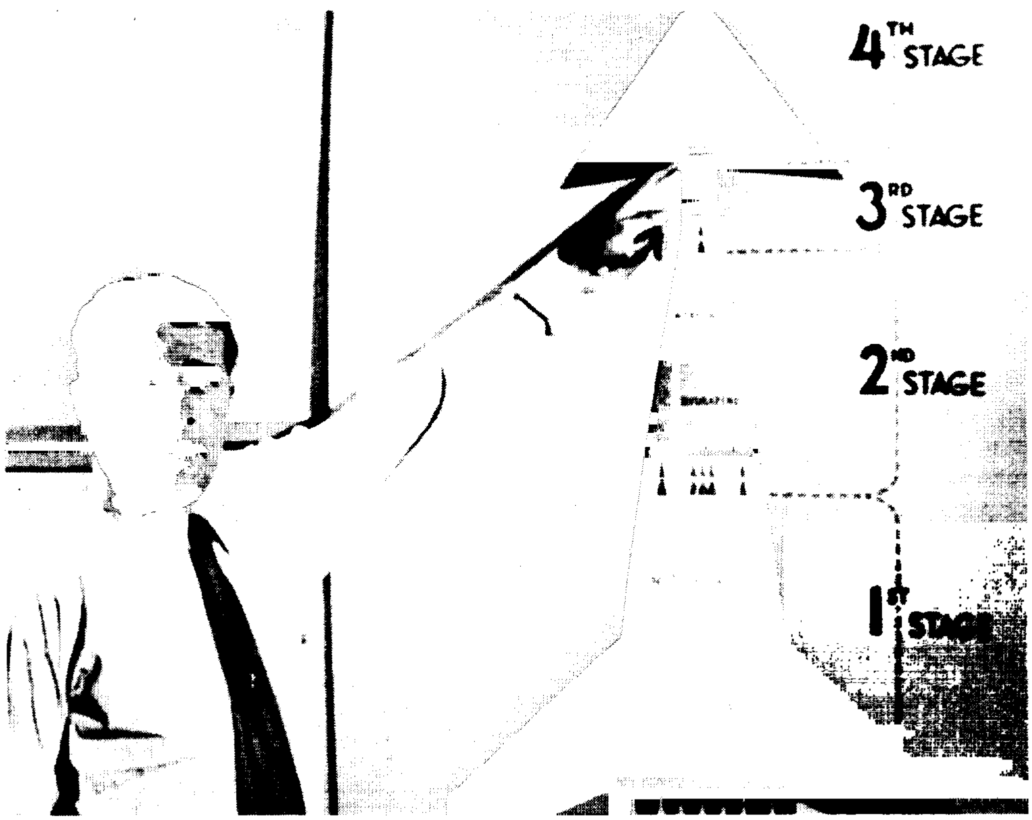

Figure 6 Wernher von Braun's ideas for the exploration of space were some of the most significant ideas to reach the public during the 1950s. Here he discusses his ideas for a piloted rocket that would travel to and from an Earth-orbiting space station. Photography from NASA collections.

[24] *TV Guide*, March 5, 1955, p. 9.

the mid-1950s, and without it NASA and the aggressive piloted programs of the 1960s could never have been approved.

The Civil Space Policy Debate

Of course, the United States was not the only nation in the immediate post-World War II era at work on the development of rockets and possessing a sense of imagination about their use in exploration. The rivalry between the United States and the Soviet Union, as the two great superpowers engaged in a "Cold War" over the ideologies and allegiances of the non-aligned nations of the world, provided the pragmatic politicians of the nation with the rationale for truly immense outlays of funds for space operations. Both saw space as a "new high ground" that must not be abandoned to the other, and its offensive and defensive potential exploited, or at least neutralized so that the other did not exploit it. It was this rivalry that prompted the development of a formal U.S. civil space program. Although modest plans for space exploration, rooted in scientific experimentation, were in place before this time,[25] the U.S./U.S.S.R. rivalry in space took a decisive turn with the Soviet Union's launch of Sputnik I on October 4, 1957. This was, literally, a shot heard around the world and nothing has been the same since.[26]

Prior to this time, proponents of an aggressive space program had been stopped at virtually every turn by the Eisenhower administration's emphasis on national security, robotic spacecraft, and fiscal conservatism. The hallmark of Eisenhower's approach to U.S. space policy was his imperturbable resistance to demands that the nation undertake

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[25] This was the Eisenhower mandated approach, and it involved the formal effort of Project Vanguard on behalf of the International Geophysical Year in 1957-1958. In this subject see, Constance McL. Green and Milton Lomask, *Vanguard: A History* (Washington, DC: NASA SP-4202, 1970). In addition, the Army's Redstone rocket team led by Major General John B. Medaris and Wernher von Braun urged a small, inert, Earth satellite launched with the Jupiter IRBM, called Project Orbiter (later named Explorer). Project Orbiter first appeared with the name "A Minimum Satellite Vehicle," the result of an August 3, 1954, meeting between Army officials at the Redstone Arsenal and Navy representatives from the Office of Naval Research. See Dr. Wernher von Braun, "A Minimum Satellite Vehicle: Based on components available from missile developments of the Army Ordnance Corps," September 15, 1954, NASA Historical Reference Collection; R. Cargill Hall, "Origins and Development of the Vanguard and Explorer Satellite Programs," *Airpower Historian* 11 (October 1964): 102-108.

[26] On the Sputnik crisis see, Walter A. McDougall, . . . *The Heavens and the Earth: A Political History of the Space Age* (New York: Basic Books, 1985); James R. Killian, Jr., *Sputnik, Scientists, and Eisenhower: A Memoir of the First Special Assistant to the President for Science and Technology* (Cambridge, MA: MIT Press, 1977); Rip Bulkeley, *The Sputniks Crisis and Early United States Space Policy: A Critique of the Historiography of Space* (Bloomington: Indiana University Press, 1991); Robert A. Divine, *The Sputnik Challenge: Eisenhower's Response to the Soviet Satellite* (New York: Oxford University Press, 1993).

crash programs competing with the Soviets.[27] Before Sputnik, Eisenhower was never particularly concerned with beating the Soviets into space, and, seeing no plain and readily attainable political goal, there was accordingly no consensus among U.S. senior policymakers for carrying on wholesale competition. Eisenhower was interested in pursuing a measured space exploration program, however, and when told that the first U.S. satellite launch was scheduled for October 31, 1957, he agreed to the timetable. Writing in his memoirs, Eisenhower commented that "Since no obvious requirement for a crash satellite program was apparent, there was no reason for interfering with the scientists and their projected time schedule."[28] In this environment, space exploration enthusiasts could not move official policy toward adoption of their accelerated spaceflight agenda.

This began to change with Sputnik I in October 1957. Eisenhower found himself besieged by political rivals who used the Soviet launching of Sputnik as a means of discrediting the Republicans and their administration. They condemned the Eisenhower administration for neglecting the American space program, reinforcing for many Americans the popular conception that Eisenhower was a smiling incompetent; it was another instance of the "do-nothing," golf-playing president mismanaging events.[29] Politicians such as G. Mennen Williams, the Democratic governor of Michigan, even wrote a poem about it:

> Oh little Sputnik, flying high
> With made-in-Moscow beep,
> You tell the world it's a Commie sky
> and Uncle Sam's asleep.
>
> You say on fairway and on rough
> The Kremlin knows it all,
> We hope our golfer knows enough
> To get us on the ball.[30]

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[27] See chapter 3 in this collection for a discussion of this effort by R. Cargill Hall. See also David Callahan and Fred I. Greenstein, "The Reluctant Racer: Dwight D. Eisenhower and United States Space Policy," unpublished paper delivered at a symposium on "Presidential Leadership, Congress, and the U.S. Space Program," on March 25, 1993, at American University, Washington, DC.

[28] Dwight D. Eisenhower, *The White House Years: Waging Peace* (Garden City, NY: Doubleday, 1965), p. 209.

[29] This proved incorrect, however, and Fred I. Greenstein demonstrated the fact in *The Hidden-Hand Presidency: Eisenhower as Leader* (New York: Basic Books, 1982). He argued that Eisenhower worked behind the scenes while giving the appearance of inaction, and in most instances his indirect approach to leadership was highly effective. This has been demonstrated for Eisenhower's space program in R. Cargill Hall, "Eisenhower, Open Skies, and Freedom of Space," IAA-92-0184, paper delivered on September 2, 1992, to the International Astronautical Federation, Washington, DC.

[30] G. Mennen Williams, quoted in William E. Burrows, *Deep Black: Space Espionage and National Security* (New York: Random House, 1987), pp. 94-94. See also Derek W. Elliott, "Finding an Appropriate Commitment: Space Policy Under Eisenhower and Kennedy," Ph.D. Diss., George Washington University, 1992.

It was a shock, creating the illusion of a technological gap and providing the impetus for a variety of remedial actions.

Senator Lyndon B. Johnson, who also saw an opportunity to discredit the Republicans as well as probably being genuinely concerned about the perception of Soviet leadership in space technology, opened hearings by the Senate Armed Services Committee on November 25, 1957. He led a review of the whole spectrum of American defense and space programs in the wake of the Sputnik crisis. Johnson's efforts found serious underfunding and incomprehensible organization for the conduct of U.S. space activities. Speaking for many Americans he remarked in two speeches in Texas in the fall of 1957 that the "Soviets have beaten us at our own game—daring, scientific advances in the atomic age." Since those Cold War rivals had already established a foothold in space, Johnson proposed to "take a long careful look" at why the U.S. space program was trailing that of the Soviet Union.[31]

These efforts were cheered, aided, and abetted by promoters of space flight, who now saw a small opening where they might press for the adoption of their aggressive space flight goals. Far from a monolithic group, these space advocates included "true believers" motivated by an expansive view of human voyages of discovery, the exploration and settlement of the Moon and other planets of the Solar System, and eventual interstellar travel.[32] But it also included industrialists who had been involved in the development of rocket technology for the Department of Defense, military officials involved in space as a national security issue, and a cadre of civilian advisors who provided expertise about scientific and technological matters to Federal government officials.[33] This alliance of enthusiasts, futurists, advisors, and representatives of the "military-industrial" complex coupled with members of Congress to provide a powerful force with which Eisenhower had to deal.

From the beginning of the hearings this combination of interests sought to craft an outcome that furthered their individual agendas. True believers in spaceflight urged the adoption of longterm and far-reaching programs that would allow humanity to get off this planet, thereby allowing the human race to survive indefinitely. In their view the human component of space flight must be the central one, with robotic probes and appli-

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[31] Speeches of Lyndon B. Johnson, Tyler, TX, October 18, 1957, and Austin, TX, October 19, 1957, both in Statements file, Box 22, Lyndon B. Johnson Presidential Library, Austin, TX.

[32] See, Ray A. Williamson, "Outer Space as Frontier: Lessons for Today," *Western Folklore* 46 (October 1987): 255-67; Stephen J. Pyne, "Space: A Third Great Age of Discovery," *Space Policy* 4 (August 1988): 187-99; John Glenn, Jr., "The Next 25: Agenda for the U.S.," *IEEE Spectrum*, September 1983, p. 91; James A. Michener, "Looking Toward Space," *Omni*, May 1980, pp. 57-58, 121; James A. Michener, "Manifest Destiny," *Omni*, April 1981, pp. 48-50, 102-104; G. Harry Stine, *The Hopeful Future* (New York: The Macmillan Co., 1983); *America's Next Decades in Space: A Report of the Space Task Group* (Washington, DC: National Aeronautics and Space Administration, September 1969); Harvey Brooks, "Motivations for the Space Program: Past and Future," in Allan A. Needell, ed., *The First 25 Years in Space: A Symposium* (Washington, DC: Smithsonian Institution Press, 1983), pp. 3-26.

[33] U.S. Senate, *Hearings before the Preparedness Investigating Subcommittee of the Committee on Armed Services, 85th Cong., 1st and 2d Sess., November 25, 26, 27, December 13, 14, 16, and 17, 1957, January 10, 13, 15, 16, 17, 20, 21, and 23, 1958* (Washington, DC: Government Printing Office, 1958).

cations satellites a useful but decidedly less-important aspect of the space exploration agenda. Their emphasis on adventure and discovery, as well as the long-range goals of exploration and colonization, were a fundamental part of the goals advanced in response to Sputnik. The representatives of what Eisenhower called the "military-industrial complex" were less pie-eyed about spaceflight and its potential, but they were no less adamant in their recommendations that increased government funding should be shunted into the development of technology for space travel. They emphasized, therefore, the need to attain superiority over the Soviet Union using standard Cold War rhetoric.[34]

The Congressional staffs, some of whom were space boosters themselves, carefully chose the witnesses for hearings about the space effort.[35] Although there were some who gave testimonies supporting the president as having the Sputnik situation well in hand, in the aggregate the testimony urged greater support and funding for space exploration.[36] During the Johnson subcommittee hearings in the fall of 1957, for instance,

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[34] *Ibid.*; U.S. House of Representatives, *Hearings before the Select Committee on Astronautics and Space Exploration, 85th Cong., 2d sess. on H.R. 11881, April 15, 16, 17, 18, 21, 22, 23, 24, 25, 28, 29, 30, May 1, 5, 7, 8, and 12, 1958* (Washington, DC: Government Printing Office, 1958).

[35] For the Senate, these included Eilene Galloway from the research staff of the Library of Congress; Glen P. Wilson, an aeronautical engineer; and Homer Stewart to handle scientific matters. For the House investigation Fred Singer, an astrophysicist at the University of Maryland, served as the scientific consultant and played a key role in the committee's hearings. See Alison Griffith, *The National Aeronautics and Space Act: A Study of the Development of Public Policy* (Washington, DC: Public Affairs Press, 1962), pp. 27-43; Glen P. Wilson, "Lyndon Johnson and the Legislative Origins of NASA," *Prologue: Quarterly of the National Archives* 25 (Winter 1993): 362-73.

[36] This is not surprising, given that the list of witnesses at these hearings reads like a who's who of the scientific and technological/military-industrial complex elite. It included Edward Teller, University of California Radiation Laboratory; Vannevar Bush, Massachusetts Institute of Technology; James H. Doolittle, Chair of the USAF Scientific Advisory Board; John Hagen, Director of the Navy's Project Vanguard; Neil H. McElroy, Secretary of Defense; Donald A. Quarles, Deputy Secretary of Defense; Wilber M. Brucker, Secretary of the Army; General Maxwell D. Taylor, Army Chief of Staff; Major General John B. Medaris, Commander of the Army Ballistic Missile Agency; Wernher von Braun, Director of the Development Operations Division of the Army Ballistic Missile Agency; Thomas S. Gates, Jr., Secretary of the Navy; Admiral Arleigh A. Burke, Chief of Naval Operations; J. Sterling Livingston, Harvard University; James H. Douglas, Secretary of the Air Force; General Thomas D. White, USAF Chief of Staff; General Curtis E. LeMay, USAF Vice Chief of Staff; Major General Bernard A. Schriever, Commander of the Air Force Ballistic Missile Division; Nelson A. Rockefeller, Rockefeller Brothers Fund; David Sarnoff, Radio Corporation of America; Robert E. Gross, Lockheed Aircraft Corp.; Dan A. Kimball, Aerojet General Corp.; Lawrence A. Hyland, Hughes Aircraft Co.; Roy T. Hurley, Curtiss-Wright Corp.; Thomas G. Lanphier, Jr., Convair Division, General Dynamics Corp.; James R. Dempsey, Astronautics Division, General Dynamics Corp.; Krafft A. Ehricke, Convair Division, General Dynamics Corp.; Donald W. Douglas, Sr., Douglas Aircraft Co.; Donald W. Douglas, Jr., Douglas Aircraft Co.; William E. Allen, Boeing Airplane Co.; James H. Kindelberger, North American Aviation; Alexander de Seversky; F.O. Detweiler, Chance Vought Aircraft; Lloyd V. Berkner, Associated Universities; Walter S. Dornberger, Bell Aircraft Corp.; Hugh L. Dryden, National Advisory Committee for Aeronautics; Lee A. DuBridge, California Institute of Technology; Frederick C. Durant III, International Astronautics Federation and American Rocket Society; William H. Pickering, Jet Propulsion Laboratory; Simon Ramo, Ramo-Wooldridge Corp.; Rear Admiral Hyman G. Rickover; Raemer Schreiber, Los Alamos Scientific Laboratory; H. Guyford Stever, Massachusetts Institute of Technology; James A. Van Allen, University of Iowa; Alan T. Waterman, National Science Foundation; Fred L. Whipple, Smithsonian Astrophysical Observatory; and Herbert F. York, Advanced Research Projects Agency, DOD; among others.

quintessential science sage Vannevar Bush warned that "We have been complacent and we have been smug" in space efforts. "We must develop a sense of urgency," added James A. Doolittle, chair of the NACA, "we must be willing to work harder and sacrifice more."[37] Emerging from this investigation was a policy to make space exploration a concerted effort both for technological development and for the national prestige it would engender in the context of the Cold War between the United States and the Soviet Union.

Congressional inquiries also assessed the nature, scope, and organization of the nation's long-term efforts in space, and led to a Senate vote on February 6, 1958, to create a Special Committee on Space and Aeronautics whose charter was to frame legislation for a permanent space agency. The House of Representatives soon followed suit. With Congress leading the way, and fueled by the crisis atmosphere in Washington following the Sputnik episode, it was obvious that some government organization to direct American space efforts would emerge before the end of the year.[38]

As a result of these activities Eisenhower recognized that he had to do something to reassert control over the political situation surrounding the Sputnik crisis. He clearly did not want to abdicate all responsibility for space policy-making to the alliance of interests who were advocating increased efforts on Capitol Hill. Accordingly, on February 4, 1958, the president asked his new science advisor, James R. Killian, named in the wake of Sputnik with the goal of coordinating efforts in the executive branch, to convene the President's Science Advisory Committee (PSAC), also established in the wake of Sputnik, to come up with a plan for space exploration. By this time, however, it was all but certain that a new space agency would be created. Its exact responsibilities, form, and location, however, were still undecided. Eisenhower was convinced whatever might be created, however, that "he didn't want to just rush into an all-out effort on each one of these possible glamour performances without a full appreciation of their great cost."[39]

Killian went to work within the executive branch to prepare a plan of action. The PSAC had been considering the creation of a civil space agency for several months and soon came forward with a proposal that placed all non-military efforts relative to space exploration under a strengthened and renamed NACA. Established in 1915 to foster aviation progress in the United States, the NACA had long been a small, loosely-organized, and elitist organization known for both its technological competence and its apolitical culture. It had also been moving into space-related areas of research and engineering during the 1950s, through the work of a Space Task Group under the leadership of Robert L. Gilruth. While totally a civilian agency, the NACA also enjoyed a close work-

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[37] *Senate Hearings*, pp. 21, 28, 60, 63-65, 113.

[38] Griffith, *National Aeronautics and Space Act*, pp. 19-24; Enid Curtis Bok Schoettle, "The Establishment of NASA," in Sanford A. Lakoff, ed., *Knowledge and Power* (New York: Free Press, 1966), pp. 162-270.

[39] L. Arthur Minnich, Jr., "Legislative Meeting, Supplementary Notes," February 4, 1958, Dwight D. Eisenhower Presidential Papers, Dwight D. Eisenhower Library, Abilene, KS.

ing relationship with the military services, helping to solve research problems associated with aeronautics and also finding application for them in the civilian sector. Its civilian character; its recognized excellence in technical activities; and its quiet, research-focused image all made it an attractive choice. It could fill the requirements of the job without exacerbating Cold War tensions with the Soviet Union.[40]

President Eisenhower accepted the PSAC's recommendations and had members of his administration draft legislation to expand the NACA into a new National Aeronautics and Space Administration (NASA). It set forth a broad mission for the agency to "plan, direct, and conduct aeronautical and space activities"; to involve the nation's scientific community in these activities; and to disseminate widely information about these activities. After some debate and revision, the National Aeronautics and Space Act was passed by Congress and Eisenhower signed it into law on July 29, 1958. The new organization started functioning on October 1.[41]

At the same time, Eisenhower directed the PSAC to formulate a coherent space policy. Brought to the president's attention in early March and revised for public release on March 26, 1958, the PSAC released a report outlining the importance of space activities. With Eisenhower's strong endorsement the policy statement emphasized scientific discovery, but recommended a cautiously measured pace. "Since there are still so many unanswered scientific questions and problems all around us on earth, why should we start asking new questions and seeking out new problems in space? How can the results possibly justify the cost?" asked the PSAC. It broke space exploration initiatives down into three broad headings without a defined timetable for completion—"Early, Later, Still Later"—each with its own projects. Only well into the "Later" phase would humans fly in space.[42]

To head the new space agency and to execute the president's space policy, Eisenhower chose T. Keith Glennan. Glennan fit perfectly into the Eisenhower administration. He was a Republican with a fiscally conservative bent, an aggressive businessman with a keen sense of public duty and an opposition to government intrusion into the lives of Americans, and an educator with a rich appreciation of the role of science and technology in an international setting. His values and perspectives found themselves replicated in NASA as he began to direct its affairs in the fall of 1958. First, Glennan worked for the development of a well-rounded space program that did not focus on "spectacular" missions designed to "one-up" the Soviets. While he was an ardent Cold Warrior and understood very well the importance of the space program as an instrument of interna-

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[40] Divine, *Sputnik Challenge*, pp. 100-105; Alex Roland, *Model Research: The National Advisory Committee for Aeronautics, 1915-1958* (Washington, DC: NASA SP-4103, 1985), 1:290-300.

[41] Lyndon B. Johnson, *The Vantage Point: Perspectives of the Presidency, 1963-1969* (New York: Holt, Rinehart & Winston, 1971), p. 277; Killian, *Sputnik, Scientists, and Eisenhower*, pp. 137-38; Robert L. Rosholt, *An Administrative History of NASA, 1958-1963* (Washington, DC: NASA SP-4101, 1966), pp. 12-17.

[42] President's Science Advisory Committee, Executive Office of the President, "A Statement by the President and the Introduction to Outer Space," March 26, 1958, copy in NASA Historical Reference Collection, NASA Headquarters, Washington, DC.

tional prestige, Glennan emphasized long-range goals that would yield genuine scientific and technological results. Second, he believed that the new space agency should remain relatively small, and that much of its work would of necessity be done under contract to private industry and educational institutions. This was in line with Republican concerns about the growing size and power of the Federal government. Third, when it grew, as he knew it would, Glennan tried to direct it in an orderly manner. Along those lines, he tenaciously worked for the incorporation of the non-military space efforts being carried out in several other Federal agencies—especially in the Department of Defense—into NASA so that the space program could be brought together into a meaningful whole.[43]

With these actions Eisenhower was able to placate and turn partially aside the coalition of interests that advocated an exceptionally aggressive space program. He had been forced by a set of political exigencies manipulated by a cadre of scientific and technical officials within the federal government—especially inside the Department of Defense and the National Advisory Committee for Aeronautics—and their counterparts in universities, corporations, and think tanks, to create a powerful, large, wealthy federal agency to carry out space exploration. But he had thwarted some of the most dear of their goals, crash programs to race the Soviet Union into space and to accomplish spectacular feats that would impress the world. Glennan contended with these people throughout his service at NASA, complaining on several occasions that "space cadets" were everywhere and that he had to fight a rearguard action to keep NASA in synch with the president's directives. On July 11, 1960, for instance, Glennan confided in his diary that a set of briefings oriented toward program planning "give every evidence of making NASA a space cadet organization. This will have to be corrected."[44]

Glennan had both to cope with those elements and still to move the program forward in a rational and sensible manner when the public, and many in the government, were more interested in spectacular developments than in resolute but mundane progress in space capability. Glennan, for instance, incurred the wrath of some in Congress in late 1959, when it appeared that the Mercury program was not moving fast enough. The joke in Washington at the time was that the first man in space would be neither a Soviet cosmonaut nor an American astronaut but Glennan, who would be launched by Congress unless he got NASA moving more quickly. Instead Glennan tried to persuade politicians to build a broad-based program that would yield valuable scientific and technological results rather than strive for a spectacular but perhaps less substantive result. He com-

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[43] These themes are well developed in J.D. Hunley, ed., *The Birth of NASA: The Diary of T. Keith Glennan* (Washington, DC: NASA SP-4105, 1993). See also, "Glennan Announces First Details of the New Space Agency Organization," October 5, 1958, NASA Historical Reference Collection; Killian, *Sputnik, Scientists, and Eisenhower*, pp. 141-44; James R. Killian, Jr., Oral History, July 23, 1974, NASA Historical Reference Collection. Eisenhower's concerns about this aspect of modern America are revealed in "Farewell Radio and Television Address to the American People," January 17, 1961, *Papers of the President, Dwight D. Eisenhower 1960-61* (Washington, DC: Government Printing Office, 1961), pp. 1035-40.

[44] Hunley, ed., *Birth of NASA*, p. 181. See also, pp. 82, 98, 160.

Figure 7 T. Keith Glennan (Left) headed NASA from the time of its creation in 1958 until the change of administrations in January 1961. Glennan built and positioned NASA in the 1950s so that his successor, James E. Webb, could use it to accomplish the remarkable task of human flight to the Moon in the 1960s. Here he inspects a model of the Mercury/Redstone rocket with Dr. Robert C. Seamans, Jr., NASA Associate Administrator. Photograph from NASA collections, no. 60-ADM-2.

mented that NASA would "work like hell" to end the Soviet lead in the space race but conceded it could take as much as five years to surpass the Soviets in what he termed the "big-chip" phase of the rivalry.[45]

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[45] "Glennan Looks to Moon, But With Purpose in Mind," *Times Herald* (Washington, DC), February 4, 1960. See also "Space Death Wouldn't Halt U.S. Effort, Glennan Says," *Baltimore Sun*, April 11, 1960; "Glennan Has Goal in Space," *New York World Telegram*, February 5, 1960; "Capital Circus," *New York Times*, December 30, 1959.

Under Glennan NASA refused "to compete with the Russians on a shot-for-shot basis in attempts to achieve space spectaculars." Glennan commented that "Our strategy must be to develop a program on our own terms which is designed to allow us to progress sensibly toward the goal of ultimate leadership in this competition."[46] Others were interested in racing the Soviets, however, and Lyndon Johnson vowed to put additional funding into any NASA budget submission so that it could do so. Glennan wrote in his diary that "Congress always wanted to give us more money. . . . Only a blundering fool could go up to the Hill and come back with a result detrimental to the agency."[47] But how well NASA could use those funds in any given year was problematic. A determined, orderly advance in space operations, therefore, motivated the management of NASA, and the Eisenhower administration viewed those who wanted to commit the nation to an all-out race with the Soviets as "spinning" so many wheels and wasting the public's resources. Eisenhower's goal, as Pulitzer Prize-winning historian Walter A. McDougall concluded, was to refrain from beginning a race against the Soviets that "might kick off an orgy of state-directed technological showmanship that would be hard to stop, might spill over into other policy arenas, and would relinquish to the Soviets the initiative in defining the fields of battle for the hearts and minds of the world."[48]

Conclusion

The politics of the creation of the National Aeronautics and Space Administration in 1958, and how it coalesced during the remainder of the Eisenhower administration, revolved around the philosophy of government, priorities of policy, and the role of individual branches of government in responding to a perceived crisis situation in Cold War international relations. That Eisenhower was able to keep from being rolled by advocates of an aggressive space program was in large measure the result of the establishment of NASA and its leadership under Glennan. In the process, the administration refused to empower the technological elite of the nation to execute a broad-based, ambitious, and expensive program.

Since the late 1950s, the debate over civil space policy has been about what type and under what time constraints space operations would be conducted, not about whether or not to have a civil space effort. Under Eisenhower, the space program was kept relatively small and NASA's budgets were limited. In so doing, promoters of a large, far-reaching program were frustrated. When John F. Kennedy took office in 1961, however, he was less committed to holding the line against advocates of an assertive space program. Indeed, he viewed them as allies in dealing with a good deal of the other

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[46] Hunley, ed., *Birth of NASA*, p. 31.

[47] *Ibid.*, p. 17.

[48] T. Keith Glennan to James R. Killian, Jr., May 27, 1959, NASA Historical Reference Collection; McDougall, . . . *the Heavens and the Earth*, p. 202.

difficult political situations present in the U.S. As a result, he and his chief advisors expressed a strong consensus that science and technology, coupled with proper leadership and the inspiration of a great cause, could solve almost any problem of society. It was that faith, as well as the Cold War necessity of undertaking something spectacular to overshadow the Soviet Union, that sparked the 1961 Kennedy decision to go to the Moon and to empower experts, in this case aerospace engineers, with the decision-making responsibility and wherewithal to execute the Apollo program.[49]

David Halberstam shrewdly observed that "if there was anything that bound the men [of the Kennedy administration], their followers, and their subordinates together, it was the belief that sheer intelligence and rationality could answer and solve anything." This translated into an ever increasing commitment to science and technology to resolve problems and point the direction for the future. They took that approach with international relations, and the space program and the techno-war in Vietnam were two direct results. They also took that road in other public policy arenas.[50]

The NASA administrator in the 1960s, James E. Webb, became the high priest of technological efforts to resolve national problems. He argued for a scientific management approach that could be used to reduce all problems to a technological common denominator and then to overcome them. He wrote as late as 1969 that "Our Society has reached a point where its progress and even its survival increasingly depend upon our ability to organize the complex and to do the unusual." Proper expertise, well-organized and led, and with sufficient resources could resolve the "many great economic, social, and political problems" that pressed the nation.[51]

The combination of technological and scientific advance, political competition with the Soviet Union, changes in popular opinion about space flight, and the unification of a broad coalition of interests arguing for a strong space program for a variety of reasons came together in a very specific way in the 1950s to affect public policy in favor of an aggressive effort in space. In many respects, James Webb's philosophy represented the triumph of that coalition of interests that had asserted without great success the argument for an accelerated space exploration in the 1950s. The crash program for the Apollo lunar landing represented the translation of that philosophy into public policy.

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[49] This deference to the authority of expertise was also seen in other technical arenas. See Bruce E. Seely, *Building the American Highway System: Engineers as Policy Makers* (Philadelphia, PA: Temple University Press, 1987); Samuel P. Hays, with Barbara D. Hays, *Beauty, Health, and Permanence: Environmental Politics in the United States, 1955-1985* (Cambridge, England: Cambridge University Press, 1987); Thomas L. Haskell, ed., *The Authority of Experts: Studies in History and Theory* (Bloomington: Indiana University Press, 1984); John G. Gunnell, "The Technocratic Image and the Theory of Technocracy," *Technology and Culture* 23 (July 1982): 392-416; Mark H. Rose and Bruce E. Seely, "Getting the Interstate System Built: Road Engineers and the Implementation of Public Policy, 1955-1985," *Journal of Public Policy* 2 (1990): 23-55.

[50] David Halberstam, *The Best and Brightest* (New York: Viking, 1973), pp. 57, 153.

[51] James E. Webb, *Space Age Management: The Large Scale Approach* (New York: McGraw-Hill Book Co., 1969), p. 15.

Chapter 5

NASA and the Challenge of Organizing for Exploration

Sylvia K. Kraemer[1]

The Eisenhower Administration's calculated policy of "open skies" and "peaceful uses of space" to enable satellite overflights of other nations virtually assured that the United States' non-defense space program would be lodged in a civilian agency.[2] Eisenhower's uneasiness over an emerging military-industrial complex, expressed in his Fare-

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[2] See R. Cargill Hall, "Origins of U.S. Space Policy: Eisenhower, Open Skies, and Freedom of Space," in John M. Logsdon, gen. ed., *Exploring the Unknown: Selected Documents in the History of the U.S. Civil Space Program, Vol. I, Organizing for Exploration* (Washington, DC: NASA SP-4407, 1995), 1:217-33.

well Address,[3] no doubt also contributed to his view that all nondefense related space activities should be assigned to a new civilian organization. Scientists—who recognized that scientific exploration of space would fare better intertwined with a "peaceful," or nonmilitary, space program—agreed with Eisenhower. The President's own Science Advisory Committee, chaired by James R. Killian, Jr. of the Massachusetts Institute of Technology, favored creating a civilian national space agency out of the nucleus of the National Advisory Committee for Aeronautics (NACA).[4]

In a March 1958 memorandum to President Eisenhower, Killian joined forces with Bureau of the Budget Director Percival Brundage and Nelson A. Rockefeller, chairman of the President's Advisory Committee on Government Organization, to make a lucid case for choosing the NACA over the proposed alternatives, the most prominent of which were the Department of Defense (DoD), the Atomic Energy Commission, a private contractor, or a new Department of Science and Technology, to lead "the civil space effort."

A New Organization

Created by the National Aeronautics and Space Act (PL 85-568), the National Aeronautics and Space Administration (NASA) opened for business on October 1, 1958, with a complement of nearly eight thousand employees transferred from the old NACA research laboratories: Langley Aeronautical Laboratory at Hampton, Virginia (established 1917); Ames Aeronautical Laboratory at Moffett Field, California, (established 1939); the Flight Research Center at nearby Muroc Dry Lake (established 1946), now known as the Dryden Flight Research Center; and the Lewis Flight Propulsion Laboratory in Cleveland, Ohio (established 1940). By the end of 1960 NASA personnel rolls had nearly doubled to over sixteen thousand.

The principal increases were a result of the tripling of NASA Headquarters personnel and the addition of portions of the Army's Ballistic Missile Agency (ABMA), renamed the George C. Marshall Space Flight Center, and the new Goddard Space Flight Center in Beltsville, Maryland. Most of Goddard's personnel had been transferred from the Naval Research Laboratory (NRL) and the Naval Ordnance Laboratory (NOL). The Jet Propulsion Laboratory of the California Institute of Technology, a contractor-owned and operated facility involved in rocket research since 1936, was also transferred from

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[3] "Farewell Radio and Television Address to the American People," January 17, 1961, *Public Papers of the Presidents of the United States: Dwight D. Eisenhower, 1960-61* (Washington, DC: U.S. Government Printing Office, 1962), pp. 1035-40. Quote from 1038-39; "military-industrial complex" phrase on p. 1038.

[4] The political and legislative origins of the National Aeronautics and Space Administration are described in Walter A. McDougall, . . . *the Heavens and The Earth: A Political History of the Space Age* (New York: Basic Books, 1986), Chapter 7, "The Birth of NASA," and Enid Curtis Bok Schoettle, "The Establishment of NASA," in Sanford A. Lakoff, ed., *Knowledge and Power: Essays on Science and Government* (New York: Free Press, 1966).

the U.S. Army to NASA. The Manned Spacecraft Center in Houston and the Kennedy Space Center at Cape Canaveral were added within the next three years.[5]

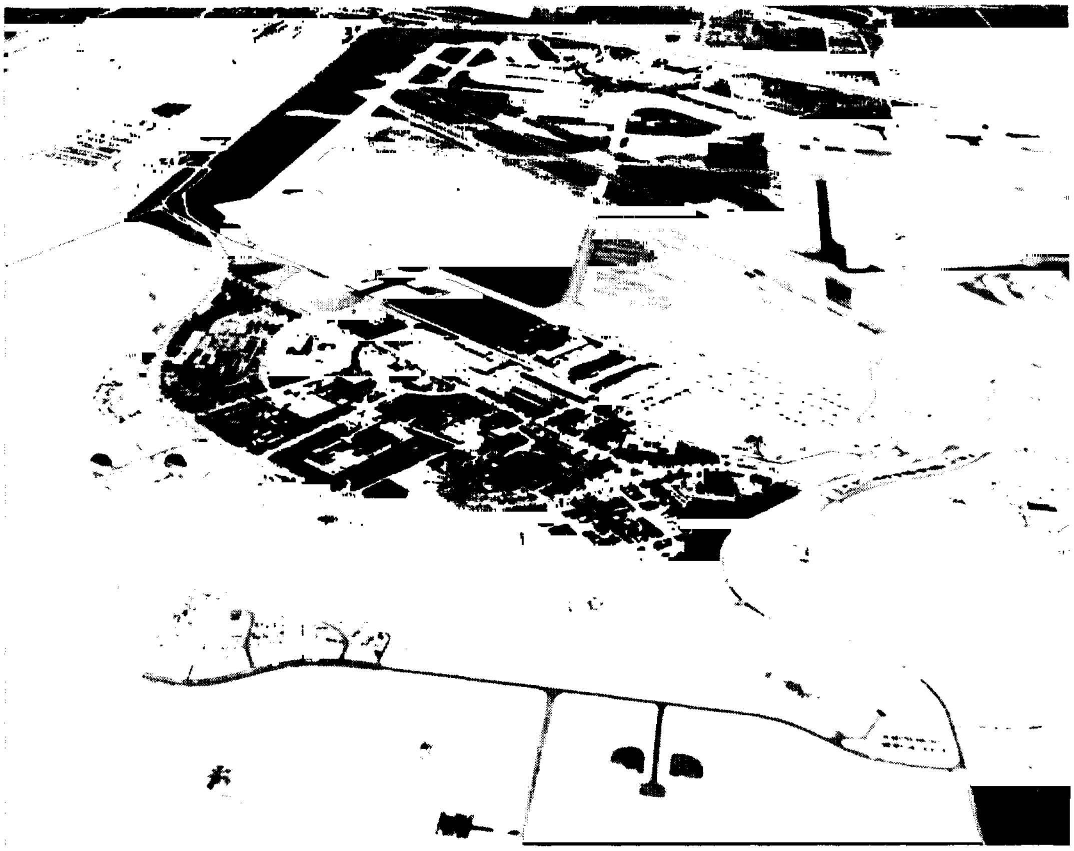

Figure 1 One of the NACA installations, the Lewis Flight Propulsion Laboratory, shown here from the air with Cleveland's Hopkins International Airport in the background, was made a part of NASA in 1958. Photograph from NASA collections, no. 72-H-1181.

[5] By the end of 1960, the old NACA laboratories and Marshall Space Flight Center accounted for 49 percent and 33 percent, respectively, of NASA's employees. (The Manned Spacecraft Center in Houston, Texas, was added in 1961. The U.S. Army's Missile Firing Laboratory at Cape Canaveral, Florida, was added to Marshall Space Flight Center's organization in 1960 and was renamed the John F. Kennedy Space Center in 1963.) The 157 personnel who had been working on the Navy's Project Vanguard, which became the nucleus of the Goddard Space Flight Center (est. 1959), were transferred to NASA in 1958 from one of the Navy's own in-house research laboratories, the Naval Research Laboratory. They were soon joined by 63 more who had been working for the Naval Research Laboratory's Space Sciences and Theoretical divisions. The next large group to transfer to NASA was the 5,367 civil servants from the U.S. Army's Ballistic Missile Agency (ABMA) at Redstone Arsenal, in Huntsville, Alabama. The ABMA had been essentially an in-house operation. The youngest NASA installations, the Manned Spacecraft Center (renamed Johnson Space Center in 1973) and Kennedy Space Center, were initially staffed by personnel from Langley Research Center and the ABMA.

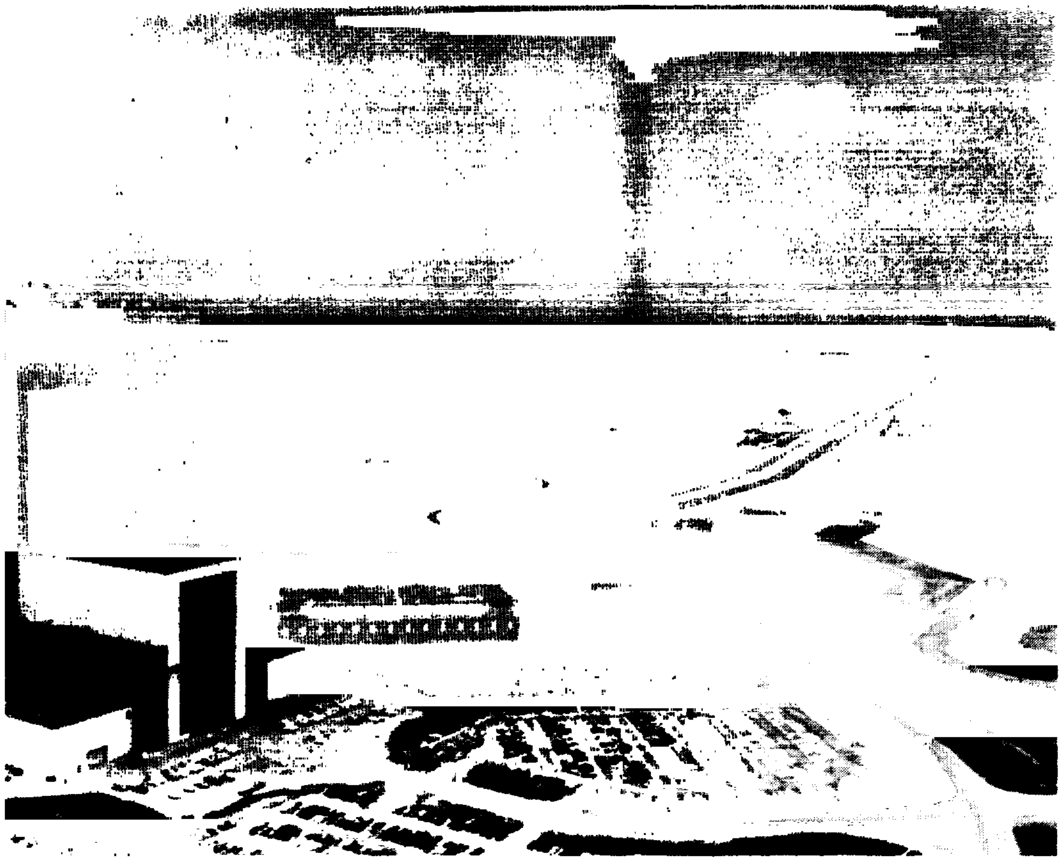

Figure 2 The NASA launch facility named in 1963 the Kennedy Space Center is shown in this 1969 photograph. The center's Vehicle Assembly Building is in the left foreground and the crawler holding the 36-story Apollo/Saturn V Moon rocket is in the center. Photograph from NASA collections, no. 69-H-909.

Because of the way NASA was initially assembled, a little over eighty percent of NASA's technical core during the 1960s and 1970s—its engineers and scientists—held within its corporate memory the experience of working with the NACA, the Army Ballistic Missile Agency, and the Navy organizations from which Goddard Space Flight Center had drawn much of its personnel. Each group would bring its own institutional culture. Predominating among NASA's initial cadre, the scientists and research engineers of the NACA (established 1915) had based their careers in an institution that had conducted research in aerodynamics and aircraft structures and propulsion systems for both industrial and military clients. Informally structured, the NACA had been overseen by its Main Committee and various technical subcommittees, and its work in aeronautical engineering was done largely by civil servants. Aside from its work in aeronautics, what distinguished the NACA as an institution was the ethos that permeated its laboratories. With its emphasis on technical competence, evaluation of one's work by technical peers, and a collegial in-house research environment thought conducive to engineering innovation, the NACA centers were not well equipped for the sweeping institutional growth and change that would complicate their life after 1958.[6]

To the technical core of the NACA were added, during NASA's first two years, the complementary Naval Research Laboratory habits of in-house engineering research and science, and, by the ABMA group, the emphasis on in-house technical development characteristic of the Army's arsenal system. The presence at the ABMA of a contingent of German rocket engineers reinforced its emphasis on in-house technical mastery and control. What these various components shared was a common culture that placed technical judgment above political competence. They undoubtedly also shared the conviction that they were embarked upon an exploratory venture unrivaled in the annals of mankind.[7]

The new agency's charter, the "Aeronautics and Space Act of 1958," had given it broad latitude to contribute "to the general welfare and security of the United States" by expanding "human knowledge of phenomena in the atmosphere and space" and preserving "the role of the United States as a leader in aeronautical and space science and technology and in the application thereof to the conduct of peaceful activities within and outside the atmosphere." Within three years—not much time given the pace of policy evolution in most popularly elected governments—John F. Kennedy provided NASA a specific mission so compelling that debate over just how NASA's broad charter was to be carried out was effectively quieted.

The Cold War, most notably in the "Sputnik Crisis," and then the flight of Yuri Gagarin in 1961, stimulated not only the creation of NASA in 1958 but its tremendous expansion in the early 1960s to carry out the Apollo program.[8] After President John F. Kennedy issued his challenge to the nation in May 1961 to send an American to the Moon and return safely within the decade—a challenge framed within the Cold War contest between the communist bloc nations and the "free world"—NASA undertook a mobilization comparable, in relative scale, to that undertaken by the U.S. to fight World War II. The agency's civil service personnel rolls increased by a factor of three, while the men and women employed on NASA contracts increased by a factor of ten. Likewise, NASA's annual budget increased an order of magnitude between 1960 and 1965, from roughly $500 million to $5.2 billion.

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[6] Alex Roland, *Model Research: The National Advisory Committee for Aeronautics, 1915-1958* (Washington, DC: NASA SP-4103, 1985), and Nancy Jane Petrovic, "Design for Decline: Executive Management and the Eclipse of NASA," Ph.D. Dissertation, University of Maryland, 1982.

[7] On NASA's culture see, Howard E. McCurdy, *Inside NASA: High Technology and Organizational Culture in the U.S. Space Program* (Baltimore, MD: Johns Hopkins University Press, 1993).

[8] Thanks to the GI Bill and its Korean War counterpart, the military services' reserve officers' training programs, cooperative work-education programs, and draft exemptions for those in engineering school or working for the government in engineering fields—NASA and its contractors were able to mobilize unprecedented numbers of engineers and scientists.

Table 1

DIMENSIONS OF THE APOLLO MOBILIZATION

Overall Budget (billions)

	Amount	Percentage Increase
FY 61	$0.964	-----
FY 62	$1.825	89%
FY 63	$3.674	101%
FY 64	$5.100	38%
FY 65	$5.250	2%

Construction of Facilities Budget (millions)

FY 61	$98.2	-----
FY 62	$217.1	121%
FY 63	$569.8	162%
FY 64	$546.6	-4%
FY 65	$522.2	-4%

Personnel

	In-House NASA	Contractor	Ratio
1958	8,040	-------	------
1960	10,200	36,500	1:3.5
1961	17,500	57,000	1:3.3
1962	23,700	115,500	1:4.9
1963	29,900	218,400	1:7.3
1964	32,500	347,100	1:10.7
1965	34,300	376,700	1:11

Source: Jane Van Nimmen and Leonard C. Bruno with Robert L. Rosholt, *NASA Historical Data Book, Volume I, NASA Resources, 1958-1968* (Washington, DC: NASA SP-4012, 1988), pp. 63-119, 134, 137-41.

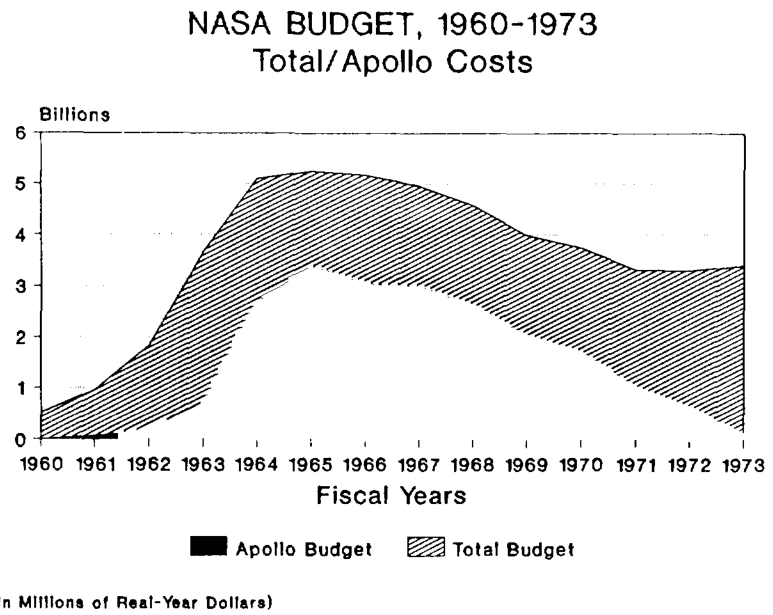

Figure 3 This graph depicts the overall funding level of NASA, 1960-1973, with the total amount dedicated to Apollo. At the height of the program NASA was dedicating approximately one-half of its annual budget to Apollo. The majority of this was spent in the research and development process during the mid-1960s.

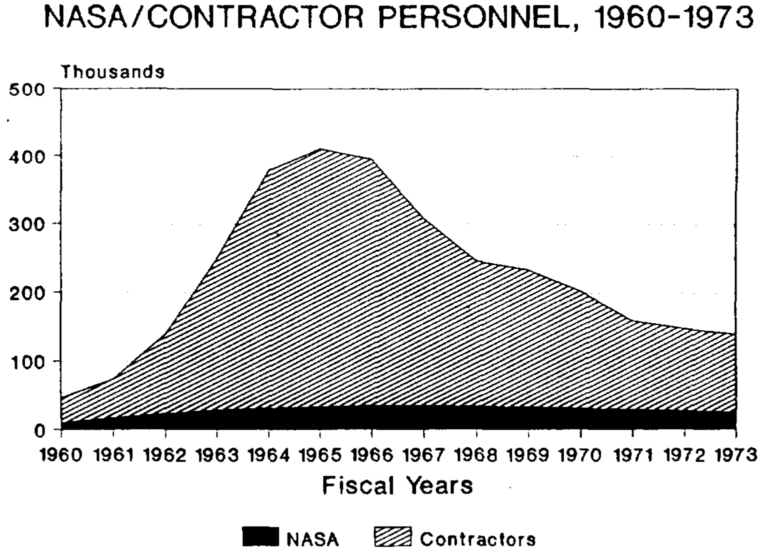

Figure 4 Although the NASA civil service workforce also grew in the 1960s, the most significant increases—and later decreases—took place among the contractors working on NASA projects.

Figure 5 NASA's Administrator between 1961 and 1968, James E. Webb.

Contracting Out

The private sector provided even more scientists, engineers, technicians and supporting personnel for Apollo than did NASA. Throughout its history, between roughly 80 percent and 90 percent of NASA's budget has gone into goods, services, and development procured from the private sector through contracts. The notion of relying on private industry and universities did not originate with NASA's Apollo-era Administrator James E. Webb (1961-1968)—though both necessity and good politics made him a natural champion of contracting out as the best way of getting the agency's work done. The NACA had supplemented its in-house research with contracts to Stanford, Massachusetts Institute of Technology, and other universities. To NASA's first administrator, T. Keith Glennan, and his ideologically sympathetic boss, President Eisenhower, reliance on the private sector came naturally.[9] Indeed, the practice had its roots deep in U.S. history.

Since the beginning of the republic, U.S. citizens have shared a widespread mistrust of large government establishments. Coupled with this mistrust has been a public faith in private enterprise that, through the mechanism of a free market, was thought the best guarantor of economic growth and a free society. On this usually bi-partisan ideological foundation, and partly in reaction to the alleged excesses of the New Deal, Federal policy encouraged government agencies to acquire their goods and services from the private sector.

The military services had been acquiring equipment and logistics support from the private sector since the early 19th century; they were well schooled in government procurement. More recently, it was the U.S. Army and U.S. Air Force, created out of the U.S. Army Air Forces under the Defense Reorganization Act of 1947 that established the Department of Defense, that had the most experience with contracting to the private sector. As a result of the Army's Manhattan Project and the ballistic missile programs managed by the Air Force's Research and Development Command, both services came to rely on private contractors for advanced engineering and development work and, in some cases, to assist in the technical direction of other development contractors—the Air Force going so far as to create the Rand and Aerospace Corporations.

Contracting out by NASA also had great practical merit: because most of the experience in the country to date in related missile and high-performance aircraft development centered in industry, which had worked as contractors to the military, the resources of industry could be marshaled more effectively *by* the government than reproduced *within* the government. NASA would be able to harness talent and institutional resources already in existence in the emerging aerospace industry and the country's leading research universities.[10] In 1959 the General Services Administration authorized NASA's use of the Armed Service Procurement Regulations of 1947, which contained important exemptions, suited to research and development work, from the principle of making awards to the "lowest responsible bidder." Contracting out promised the additional political advantage of dispersing Federal funds around the country and, as a consequence, creating within the Congress a political constituency with a material interest in the health—and management—of the space program. The attempt to meld different institutional cultures into a single organization was not without its problems. For example, when the California Institute of Technology's Jet Propulsion Laboratory became affiliated with NASA on January 1, 1959, its managers believed the lab would be called upon to play the dominant role in determining America's space exploration agenda. NASA had a much more limited role in mind for JPL, however, and the resulting conflict

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[9] On Glennan see J.D. Hunley, ed., *The Birth of NASA: The Diary of T. Keith Glennan* (Washington, DC: NASA SP-4105, 1993).

[10] One NASA installation, the Jet Propulsion Laboratory of the California Institute of Technology in Pasadena, California, would remain wholly a contractor operation. For an excellent and brief discussion of the NASA acquisition process, see Arnold S. Levine, *Managing NASA in the Apollo Era* (Washington, DC: NASA SP-4102, 1982), Chapter 4.

between these divergent expectations laid a foundation for lingering animosity between the two institutions.[11]

By 1961 the Federal government had been contracting to the private sector for much of its research and development work for two decades, since World War II. Enough questions had been raised about the wisdom of that policy to prompt President John F. Kennedy to ask the Director of the Bureau of the Budget (BoB) to review it. BoB Director David E. Bell was joined in this task by the Secretary of Defense (Robert S. McNamara), the administrator of NASA (James E. Webb), the chairman of the Civil Service Commission (John W. Macy, Jr.), the chairman of the Atomic Energy Commission (Glenn T. Seaborg), the Director of the National Science Foundation (Alan T. Waterman), and the Special Assistant to the President for Science and Technology (Jerome B. Wiesner). The Report—which came to be known as the "Bell Report"—constituted a detailed and comprehensive review of Federal contracting for research and development.

The Bell Report affirmed the Federal government's policy of relying "heavily on contracts with non-Federal institutions to accomplish scientific and technical work needed for public purposes." At the same time, it cautioned that "the management and control of such programs must be firmly in the hands of full-time Government officials clearly responsible to the President and the Congress. With programs of the size and complexity now common," it continued,

> . . . the Government [must] have on its staff exceptionally strong and able executives, scientists, and engineers, fully qualified to weigh the views and advice of technical specialists, to make policy decisions concerning the types of work to be undertaken, when, by whom, and at what cost, to supervise the execution of work undertaken, and to evaluate the results.

This requirement, according to the Bell group, was not being met: "In recent years there has been a serious trend toward eroding the competence of the Government's research and development establishments—in part owing to the keen competition for scarce talent which has come from Government contractors." The solution, advised the Budget Director and heads of Federal research and development agencies, was not "setting artificial or arbitrary limits on Government contractors" but creating a working environment and offering salaries that would better enable the government to compete with the private sector for top scientific and engineering talent. However wise and well-intentioned the Bell Report's recommendations may have been, they do not seem to have had great effect. "Contracting out" continues to this day to be a primary issue among NASA managers, scientists, and engineers.

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[11] Clayton Koppes, *JPL and the American Space Program* (New Haven, CT: Yale University Press, 1982).

Program Management

Not only were NASA's procurement procedures based on those of the military establishment, but NASA made extensive use of the military's experience in program management as well. The ratio of military detailees to civilians working in NASA increased steadily between 1960 and 1968.[12] Many of the detailees were Air Force or Navy career officers assigned to program or operations management positions. For example, 103 of the roughly 180 military detailees in NASA at the beginning of 1963 were career Navy or Air Force officers.[13] Though fewer in number, program managers who had honed their skills in private industry also helped to manage the NASA enterprise. For example, NASA's Office of Manned Space Flight was led during much of the 1960s and 1970s by men who had come from industry, viz., George E. Mueller (Space Technology Laboratories), Dale D. Myers (North American Rockwell), and John F. Yardley (McDonnell Douglas Astronautics).

The epitome of the proven military program manager at NASA was U.S. Air Force Major General Samuel C. Phillips. Schooled in Air Force research and development program management at Wright Patterson Air Force Base, Ohio, Phillips was assigned in 1959 to manage the development of the "Minuteman" intercontinental ballistic missile. Phillips was convinced that the development of a new technology system required that the program head have centralized authority over engineering, configuration management, procurement, testing, construction, manufacturing, logistics, and training. Phillips' success with the Minuteman program won the admiration of NASA's Associate Administrator for Manned Flight George Mueller, who brought Phillips to NASA where he served as Deputy Director and then Program Director for the Apollo program.[14]

What this conglomeration of assorted talents drawn from NASA and the military wrought was not simply the historic feat of placing men on the Moon and bringing them back safely. Less visible but no less important was their catalytic role in the emerging ability of U.S. industry to develop, manufacture, and operate large, complex and sophisticated technical systems. In 1968, *Science* magazine, the publication of the American Association for the Advancement of Science, observed:

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[12] Jane Van Nimmin and Leonard C. Bruno with Robert L. Rosholt, *NASA Historical Data Book, Vol. I: NASA Resources 1958-1968* (Washington, DC: NASA SP-4012, 1988), 1:80-81, 98-99.

[13] Albert F. Siepert, Memorandum to James E. Webb, February 8, 1963, NASA Historical Reference Collection, NASA History Office, Washington, DC. A list of positions "requiring USAF officers" forwarded by NASA to the Department of the Air Force in 1964 included: director, program control, Apollo; director, program control, Saturn V; deputy director for program management, Apollo spacecraft; assistant to director for program management, Saturn V; chief, configuration management, Apollo spacecraft; configuration management officer, Saturn V; chief, configuration management, Saturn I-IB; configuration management officer, Gemini; configuration management officer, Apollo launch site; assistant deputy director for program management, Apollo program office; configuration management officer; and chief, mission requirements, Apollo. Attachment to Eugene M. Zuckert, Secretary of the Air Force, Memorandum to Hugh L. Dryden, Deputy Administrator of NASA, May 27, 1964, NASA Historical Reference Collection.

[14] That Phillips enjoyed continuing esteem long after Apollo was reflected in NASA's request that he head a comprehensive post-*Challenger* accident study of NASA's management practices.

In terms of numbers of dollars or of men, NASA has not been our largest national undertaking, but in terms of complexity, rate of growth, and technological sophistication it has been unique. . . . It may turn out that [the space program's] most valuable spin-off of all will be human rather than technological: better knowledge of how to plan, coordinate, and monitor the multitudinous and varied activities of the organizations required to accomplish great social undertakings.[15]

Figure 6 Samuel C. Phillips headed the Apollo Program Office for NASA throughout much of the program. A veteran of ballistic missile development in the U.S. Air Force, he had headed the Minuteman development program. After his tour with NASA, Phillips returned to the Air Force. Photograph from United States Air Force collections.

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[15] Dael Wolfe, Executive Officer, American Association for the Advancement of Science, editorial for *Science*, November 15, 1968.

NASA and military managers responsible for developing new aerospace technologies stimulated the government's contractors in U.S. industry to adopt program management and systems engineering strategies that would promote their survival in a market dominated by a few large Federal customers.

The forces that have influenced the management strategies characteristic of U.S. industries at any given time have varied both with the nature of contemporary economic trends and with the nature of the goods being produced. For example, in the United States during the 1880s and 1890s, in an era before the triumph of mass media consumer advertising, companies sought to control markets by controlling production and/or prices. Firms producing relatively undifferentiated commodities (e.g., whiskey, salt, coal, tobacco, sugar, kerosene) attempted to combine financial as well as management structures to achieve more effective market control within an industry. Toward the end of the century such combinations were increasingly subject to state and Federal anti-trust legislation. Successful prosecutions under the Sherman Anti-Trust Act of 1890 brought about the dissolution of such "horizontally integrated" firms as the Standard Oil Company of New Jersey and the American Tobacco Company.

Meanwhile, U.S. firms that began to produce increasingly complex manufactured items sought to achieve economies of scale in an expanding market through mass production and volume retailing, (e.g., sewing machines, automobiles, typewriters). By integrating vertically—controlling as many steps in the production of an item as possible, from raw material through manufacture and even marketing—firms (e.g., Carnegie Steel) combined to create even larger companies better able to withstand the economic oscillations of the period between the end of the Civil War and 1896.

The new large enterprises could no longer be administered informally, with control of markets management's principal preoccupation. Creative managers of some of these enterprises (in, for example, the tobacco, meat-packing, and agricultural power machinery industries) developed the centralized, functionally departmentalized organizational structure. After 1900, a new wave of expansion occurred in industries exploiting new technologies such as electrification and the gasoline engine. Product diversification became a common strategy for expansion in firms that could exploit systematic research and development—firms in the chemical, rubber, automobile, and electrical industries. Product diversification, in turn, required a different organizational approach to management. The strategy of diversification was followed by decentralization in these firms' organizational structures.

Decentralization, however, posed its own administrative problems for these firms. How was authority to be distributed among headquarters and field activities? The most common solution was that developed by managers of the railroads nearly a half-century before: the multi-divisional line-and-staff organization, by which authority was delegated from headquarters to plant managers in the field (who could not otherwise be held accountable for the performance of their units), while managers of centrally located auxiliary or service functions set standards and procedures.[16]

[16] Alfred D. Chandler, Jr., *Strategy and Structure: Chapters in the History of American Industrial Enterprise* (Cambridge, MA: MIT Press, 1962), Chapters 1-2, *passim.*

In post World War II America, several new forces began to make themselves felt on U.S. industry and, as a consequence, gave rise to new management strategies. Among these was the entrance of the public sector—primarily the Federal government—into the marketplace as a significant buyer. Another was the emergence of a substantial market for, and a responding productive capacity for, goods and services having highly sophisticated technological ("hardware," "software," and "services") components.

The importance of technological sophistication as a driving force in this new market cannot be overestimated. The largest public sector buyer, the military establishment, seeking out ever improved weapons systems, funded industrial research and development both indirectly as a buyer of newer and more advanced systems, and directly as the largest single investor in research and development.[17] How much the U.S. economy has been affected by these two factors—the Federal government as buyer, and that buyer's interest in new technologies—is reflected in the top five industries (measured by sales) in the United States in 1988. Heading the list are two U.S. industries well-established before World War II: petroleum refining ($284.3 billion) and motor vehicles and parts ($273.1 billion). Third, fourth, and fifth are industries that were initially stimulated by the Federal government's post-World War II appetite for technologically sophisticated systems and its ability to find ways to pay for them: electronics ($115.3 billion), aerospace ($112.8 billion), and computers and office equipment ($112.6 billion).[18] The sales and capital represented by these figures grew on a foundation built of successfully managed government research and development programs.

To appreciate the complexity of the technical management and quality controls, not to mention coordination and accounting, that government and industrial managers faced in assuring the success of one major NASA program, consider the prime contracts awarded to industry to design, build, test, and certify the principal components of the Saturn V alone: Boeing Co., S-IC, first stage (powered by 5 F-1 engines); North American Aviation, S-II, second stage (powered by 5 J-2 engines); Douglas Aircraft Corporation, S-IVB, third stage (powered by a single J-2 engine); Rocketdyne Div. of North American Aviation, J-2 and F-1 engine; and International Business Machines (IBM), Saturn instrument unit.[19]

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[17] Ross M. Robertson, *History of the American Economy* (New York: Harcourt, Brace & World, Inc., 1964 ed.), p. 555. In 1946-1947 the federal government paid 24 percent, and industry paid 72 percent, of the dollars (est. $2.1 billion) spent on industrial research and development during that period. By 1969 the federal government's share of the total (est. $28 billion) had increased to 40 percent and industry's share declined to 58 percent. Which sector (private or public) actually spent the rapidly increasing number of dollars devoted to research and development during 1946-1969 underwent a comparable change: industry spent 62 percent of the nation's R&D dollars on 1946-1947 and 76 percent in 1969.

[18] *The World Almanac and Book of Facts* (New York: World Almanac, 1990), p. 86, data from *Fortune* magazine.

[19] North American Aviation was bought by Rockwell and was known as North American Rockwell Corp. after September 1967. In 1967 Douglas Aircraft Co. and the McDonnell Corp. merged, becoming the McDonnell Douglas Corporation. The former Douglas division in California became the McDonnell Douglas Astronautics Co., (MDAC).

Were this the extent of industrial contractor involvement in the program, that would have been management challenge enough. In addition, a *partial* listing of the *subcontracts* these contractors awarded to other firms that "played a major role in the development and production of the Saturn V launch vehicle" would have to include the 50 subcontractors to Boeing, 91 subcontractors to Douglas Aircraft, 54 subcontractors to IBM, 28 subcontractors to North American Space Division, and 51 subcontractors to North American Rocketdyne.[20] These well over 250 firms provided innumerable parts and components, ranging from hydraulic hoses to analog computers, all of which had to meet exacting specifications for integrated fit and performance. "I wish to emphasize," remarked a Marshall Space Flight Center procurement officer during the bidding for the S-II stage contract, "that the important product that NASA will buy in this procurement is the efficient management of a stage system."[21]

So impressive was the management undertaking involved in developing and fabricating the Apollo/Saturn systems that even before the historic Apollo 11 mission left the launch pad on the morning of July 16, 1969, the Committee on Science and Astronautics of the U.S. House of Representatives asked key industry Apollo/Saturn contractors and NASA program managers to review their program management practices. Their published responses make tedious reading, littered as they are with charts and acronyms and general ineloquence, but they have an important story to tell. Unlike the industrial firms of earlier periods of U.S. history, the firms that supplied the aerospace programs of NASA and the military were engaged in the low-volume production of items that were complex, novel, and relatively unique; thousands of "end items" produced by dozens of different suppliers and manufacturers had to fit and function together, be produced on schedule, and at the levels of reliability called for by manned missions. Thus the efficiency-seeking attributes of the traditional "American system of manufacture" (use of standardized interchangeable parts and continuous process manufacture) no longer applied.

The "efficiency" inspired organizational structure of functionally distinguished units (e.g., finance, accounting, marketing, research, facilities, engineering, testing, manufacture, logistics, etc.), adequate for the production of essentially undifferentiated products, would not suffice. "Early in the development phase of the Apollo/Saturn effort," recalled Rocketdyne's vice-president of management planning and controls, "Rocketdyne management recognized that the traditional functional organizational alignment was not adequate to direct the effort of the various engine programs effectively. To ensure the necessary concentration of effort, it was decided to establish separate product organizations with responsibility for the development of specific types of engines."[22]

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[20] Roger E. Bilstein, *Stages to Saturn: A Technological History of the Apollo/Saturn Launch Vehicles* (Washington, DC: NASA SP-4206, 1980), *passim*, and Appendix E.

[21] Manned Space Flight Center, "Minutes of the Phase II Pre-Proposal Conference for Stage S-II Procurement on June 21, 1961," JSC files. Quoted in Bilstein, *Stages to Saturn*, p. 211.

[22] "Apollo Program Management: Staff Study for the Subcommittee on NASA Oversight, U.S. House of Representatives, Committee on Science and Astronautics, 91st Congress, 1st sess." (Washington, DC: U.S. Government Printing Office, 1969), p. 122.

Not all companies had been organized like Rocketdyne; Boeing's management was "basically decentralized and organized around product line responsibilities," one in which "the functional executive provides a unifying force which crosses the boundaries of the various line organizations. . . ." Nonetheless, at Boeing the "line organization managers" had the "ultimate authority and responsibility for carrying out The Boeing Co.'s contractual and related commitments to its customers."[23]

The novelty and relative uniqueness of the aerospace industry's products necessarily meant that little would be "standard"; the ability to respond intelligently and quickly to failures would become a critical management responsibility. That responsibility was felt especially acutely among government (NASA) managers responsible for the Saturn program's success:

> . . . such [Apollo/Saturn program management] features as actions for early problem detection, actions and process for problem solving, and action and processes for recovery from anomalies and failures are basic features. . .[24]

> . . . the system must provide visibility and flexibility. You need the visibility to identify nonproductive tasks and you need the flexibility to redirect the effort. Otherwise, you would be using up limited resources on tasks that were no good. Visibility and flexibility imply a knowledgeable decision point close to the work.[25]

The project manager, the program manager, and their staff became the "knowledgeable decision" points "close to the work" that government and industry created to manage the development and production of specialized technological systems. "The heart of the Program Management System," explained one NASA program manager,

> is the Project Manager who is responsible for the design, fabrication, test, delivery, and successful performance of a major piece of hardware, a product best exemplified by a stage of the launch vehicle. To achieve his goal, the Project Manager has clear lines of authority and responsibility as well as clear channels of coordination with supporting entities. These have been committed to clear, concise documented agreements. . . . In addition to management by product, such as the S-II Stage, the Program and Project managers also manage, to an extent, by function. These functional management elements . . . permeate the entire program. . . . These elements insure, within their disciplines, a continuous coordination between the functional elements [among other NASA organizations] . . . enabling many things to be handled at the working level.[26]

Critical communication and coordination between government "customers" and industrial contractor organizations required of the latter that they develop management sys-

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[23] H.H. Gunning, (Boeing Co.) *Ibid.*, pp. 15-16.

[24] Eberhard F.M. Rees (NASA Marshall Space Flight Center), *Ibid.*, p. 9.

[25] R.L. Brown (NASA Marshall Space Flight Center), *Ibid.*, p. 13.

[26] Edmund F. O'Connor, "General Program Management," *Ibid.*, pp. 247-48.

tems that paralleled, or mirrored, those NASA established. One Rocketdyne manager described NASA's (and DoD's) impact on the aerospace industry this way:

> During the past seven years NASA has had a significant and favorable influence in the development of advanced management systems within Rocketdyne. Program Planning and control requirements specified by both DoD and NASA have stimulated such management systems activity as development and implementation of the Rocketdyne Cost Management System, the Mechanized Production Control System, the Mechanized Inventory Control System coupled with the Required Inventory Control System, the Mechanized Quality Performance System, and the Mechanized Time-keeping System, to name a few. New concepts such as the well-defined program organization operating in a program/functional matrix relationship, the assignment of specific individuals to manage all activity on product-oriented elements of program work breakdown structures, and the application of the multiple accountability technique also saw their genesis during this period.[27]

Similar managerial adaptations occurred throughout the aerospace industry.

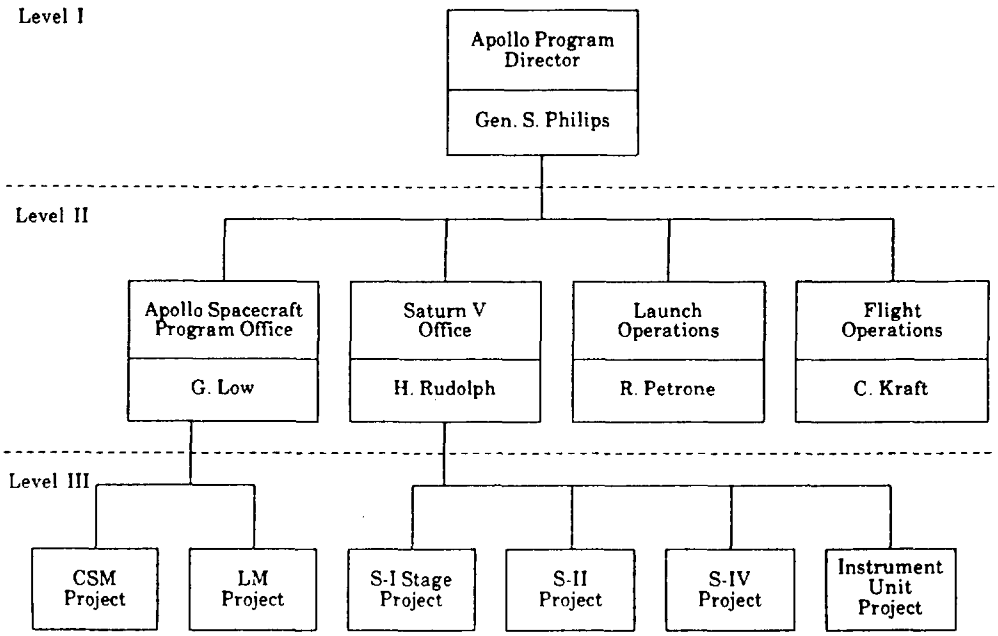

Figure 7 The Apollo Program Management Concept as established by Samuel C. Phillips.

[27] *Ibid.*, p. 126.

The government's and the aerospace industry's strategy for managing the design and development of large, complex, and relatively unique technical systems—or program management—had an important political dimension as well. The project (the development of a single entity or system) and the program (a cluster of interrelated projects) soon became, in effect, products and product lines marketed by the military and NASA to the Congress and the White House. NASA learned, as the military had learned, that the Congress, relatively stingy with funds for abstract and indefinite activities like fundamental research, could be persuaded to open the public purse for clearly defined packages of concrete "end items" with specific missions. Concrete end items meant actual hardware contracts that might benefit particular congressional constituencies. The Apollo program, like the Manhattan Project before it, was just such a package. A program thus became a bureaucratic and budgetary device for framing and executing projects to explore space and advance aeronautical technology.[28] The design and execution of a successful project became the measure of success, as many of NASA's people got caught up in the annual need to market the agency's projects and programs to the Congress to obtain the appropriations necessary to sustain their work.

In an early (1961) reorganization NASA sought to discourage internecine competition for resources that developed when an agency organized itself around hardware programs by identifying its own programs with broadly framed goals instead. The Apollo program represented one such goal.[29] The ultimate effectiveness of this approach, however, depended somewhat on the nature of the goal used—on the variety of realistic hardware approaches that could be used to achieve it. For example, the goal of "Space Sciences" was fairly diffuse; many hardware projects could be embraced by it. This was less true for costly projects. After Apollo, only the shuttle and the hoped-for Space Station—each a very specific hardware program that would require relatively large portions of the agency's total budget—emerged to satisfy the goal of manned space exploration. To appreciate the emergence and effect over time of the "program" both as a managerial and as a political device, note its absence in Hugh L. Dryden's speech on the fledgling space program, given when NASA was only a few months old.

A Culture at Risk

It would be difficult to exaggerate the significance of the policy of "contracting out" for the way NASA went about its daily work. Virtually every aspect of the agency's business was ensnared in the dense forest of regulations and procedures of

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[28] The NACA's more modest aeronautical research role—the "service" it provided the military and aviation industry—was rapidly replaced by NASA's need to direct its research and development know-how to specific programs, in particular, the manned spaceflight sequence known as Mercury, Gemini, and Apollo. Conceptually and administratively, the NASA program became the umbrella under which projects were justified and planned, congressional authorization and appropriations obtained, private sector sources solicited and evaluated, contract awards made, and those contracts administered.

[29] Levine, *Managing NASA in the Apollo Era*, p. 5.

Federal acquisitions policy. The number of procurement actions processed by NASA quadrupled from roughly 44 thousand in 1960 to almost 190 thousand in 1963; by 1965, NASA was processing almost 300 thousand actions, or almost seven times the actions the agency was managing only five years before. The dollar value of the average NASA contract more than doubled as well. However, during the same period (1960-1965), NASA's personnel increased by only a factor of three, and only a fraction of them was qualified to manage or monitor contractors. Thus, the burden of implementing the Government's "contract out" policy was borne increasingly by NASA's technical people. Engineers who had come to NASA (or earlier, to the NACA) to do engineering found themselves increasingly cast in the role of overburdened contract monitors, ever more remote from the "hands-on" work that had attracted them in the first place.

Originally an aggregate of essentially independent, in-house research organizations, NASA also struggled with the centralized controls inherent in large-scale program management. As NASA faced tighter budgets after 1966, as shown in Table 2, competition among the former NACA laboratories, new NASA centers, and Headquarters, intensified. Because the centers managed the contractors, and because the centers housed NASA's technical expertise, they acquired the power of fiefdoms—and were often so called. Nonetheless, NASA sought to retain the discipline orientation of the NACA's decentralized laboratories—further accentuating a tension between aspirations of various research disciplines and program organization that would persist through much of NASA's institutional life in the next thirty years.

The agency's inherited culture struggled against centralization at the government-wide level as well. When the NACA was transformed in 1958 into NASA, the committee structure by which it had been administered was abandoned for a hierarchical and centralized management structure. Centralized Federal administrative controls that evolved during the 1940s and 1950s—controls like standardized personnel management, budgeting, procurement, and operating procedures—were imposed on NASA by the Bureau of the Budget (after 1970 the Office of Management and Budget, OMB), the Civil Service Commission (after 1979 Office of Personnel Management, OPM), and ultimately, of course, the U.S. Congress.

The proportion of NASA's total in-house permanent workforce consisting of scientists and engineers gradually increased from one-third in 1958 to slightly less than one-half in 1970. At the same time, the ratio of NASA's contractor to civil-service employees increased from roughly 3 to 1 in 1960 to 11 to 1 in 1965 (See Table 1). After the post-FY 1966 downward slide in NASA's funding, that ratio declined. Assuming an increase in externally imposed, and thus difficult to change, administrative burdens on NASA from 1960 forward, those burdens had to be carried increasingly by the agency's civil-service scientists and engineers.[30]

[30] Sylvia Doughty Fries, "Apollo: A Pioneering Generation," International Astronautical Federation, 37th Congress (October 9, 1986), Ref. No. IAA-86-495.

Table 2
U.S. SPACE BUDGET IN CURRENT DOLLARS - 1959-1990
(Budget Authority in Billions of Dollars)

Fiscal Year	NASA Total	NASA Space	Defense	Other	Total Space
1959	0.331	0.261	0.490	0.034	0.785
1960	0.524	0.462	0.561	0.043	1.066
1961	0.964	0.926	0.814	0.068	1.808
1962	1.825	1.797	1.298	0.200	3.295
1963	3.673	3.626	1.550	0.259	5.435
1964	5.100	5.016	1.599	0.216	6.831
1965	5.250	5.138	1.574	0.244	6.956
1966	5.175	5.065	1.689	0.217	6.971
1967	4.966	4.830	1.664	0.216	6.710
1968	4.587	4.430	1.922	0.177	6.539
1969	3.991	3.822	2.013	0.141	5.976
1970	3.746	3.547	1.678	0.115	5.340
1971	3.311	3.101	1.512	0.127	4.740
1972	3.307	3.071	1.407	0.097	4.575
1973	3.406	3.093	1.623	0.109	4.825
1974	3.037	2.759	1.766	0.116	4.641
1975	3.229	2.915	1.892	0.107	4.914
1976	3.550	3.225	1.983	0.111	5.319
TQ	0.932	0.846	0.460	0.310	1.340
1977	3.818	3.440	2.412	0.131	5.983
1978	4.060	3.623	2.738	0.157	6.518
1979	4.596	4.030	3.036	0.178	7.244
1980	5.240	4.680	3.848	0.160	8.688
1981	5.518	4.992	4.828	0.158	9.978
1982	6.044	5.528	6.679	0.234	12.441
1983	6.875	6.328	9.019	0.242	15.589
1984	7.248	6.648	10.195	0.293	17.136
1985	7.573	6.925	12.768	0.474	20.167
1986	7.766	7.165	14.126	0.368	21.659
1987	10.507	9.809	16.287	0.352	26.448
1988	9.026	8.302	17.679	0.626	26.607
1989	10.969	10.098	17.906	0.440	28.444
1990	13.073	12.142	19.382	0.330	31.854

Source: *Aeronautics and Space Report of the President, Fiscal Year 1991 Activities* (Washington, DC: NASA, 1991), p. 180.

Among externally imposed management controls, the Federal personnel system has proven as critical to NASA as Federal acquisitions policy. NASA's predecessor, the NACA, had struggled against civil service pay scales and hiring/promotion procedures and ceilings which, the NACA insisted, made it difficult to recruit and retain good engineers. NASA was able to obtain 525 "excepted" positions[31] to hire the talent it needed to carry out the Apollo program. However these were indeed exceptions—exceptions to

[31] Appointments are exempt from standard Federal civil service classifications and salary ranges.

a long-term, systemic disregard by the Federal personnel system of its impact on the agency's culture of technical competence. That system was and remains strongly biased toward seniority and generic functions; it assumes that increases in rank and salary should be directly related to increasing supervisory or managerial responsibilities.

Compounding this systemic barrier to "advancement" for engineers has been a cultural prejudice that goes back to Greek and Roman antiquity, the notion that those who work with ideas have greater social value than those who work with their hands—or "things." For typical managers, the hierarchical and centralized structure of power in most organizations (not excepting NASA) reinforces their increasing remoteness, as they move "up the ladder," from practical, day-to-day concerns and "hands-on" work. More than four-fifths of the NASA engineers recruited during NASA's first decade "advanced" into management positions, and among the older engineers who were employed with NASA or the NACA before 1960, over 90 percent ended their careers in management positions. Occasionally a NASA engineer has risen to the level of GS-16 without moving into management, but the widespread perception within the agency has been that the dual-career ladder works only for the very exceptional few. Thus many NASA engineers' occupations diverged increasingly from their vocations as they began to spend more of their days doing work for which they had not been trained and may have had little natural inclination. On the other hand, some NASA engineers, fearing obsolescence in engineering careers, considered management a legitimate and productive alternative for individuals with some understanding of how technical programs work.[32] Engineers turned managers could then leverage their knowledge and experience through the projects for which they were responsible.

Looking for a Mission

The Apollo program was unarguably an enormous achievement. Nevertheless the transient motives behind the program, and the rapid mobilization of funds and personnel that made success possible, impeded the gradual evolution of a stable and broad public consensus about the nation's purpose in space. As more than 13,000 NASA engineers worked at their daily routines during the mid-1960s, pursuing the adventure to which President Kennedy had summoned them, the solid ground of common national purpose had already begun to shift ominously under their feet. By 1965, John F. Kennedy lay buried, and three years later he would be joined by Robert Kennedy, who, along with Martin Luther King, would be victims of violence. Violence in the United States, as race-related riots spread from urban ghetto to urban ghetto, was matched by U.S. violence abroad.

Television, which had been acquired by 94 percent of all U.S. households by the mid-1960s, rendered these scenes of violence commonplace and provided a world stage

[32] The information in this section is drawn from Sylvia Doughty Fries, *NASA Engineers and the Age of Apollo* (Washington, DC: NASA SP-4104, 1992).

for an outpouring of public protest against U.S. military involvement in Vietnam.[33] In March of 1968, that champion of space exploration, President Lyndon B. Johnson—so tough in the battle against the North Vietnamese, so tough in the battle against poverty and race discrimination—formally abandoned any hope of reelection. Raising the specter of runaway inflation as costs for the war in Vietnam and the social programs of the "Great Society" mounted, Johnson's economic advisers had persuaded the president in 1965 that the budget for the space program would have to be contained. There was diminishing enthusiasm outside NASA for an ambitious space program to follow the Apollo adventure. In fiscal year 1966, NASA's budget began its downward slide (though actual outlays for 1966 were the highest of the decade).[34]

The political consensus that had produced the visionary National Aeronautics and Space Act of 1958 began to dissipate before the first few Apollo missions were flown.[35] NASA's fiscal year 1971 budget took a battering from the OMB in 1969, forcing the cancellation of Apollo missions 18 through 20 and leading Webb's successor Thomas O. Paine to complain that the OMB had ignored the ambitious recommendations of the White House's own Space Task Group, chaired by Vice-President Spiro T. Agnew. A staunch supporter of a vigorous manned space program (and hence further Apollo manned expeditions to the Moon), Paine was willing to cease continued production of the Saturn launch vehicle and to defer the Viking project to launch an unmanned spacecraft to land on the planet Mars to pay for further manned lunar missions. Viking survived, as did a proto-space station (Skylab) fashioned from Apollo-Saturn hardware and flown during 1973; but the mighty Saturn did not. NASA was able to persuade the Nixon administration that a new Space Transportation System featuring a reusable orbiter spacecraft and solid propellant rocket boosters, flying 30 or more times a year, would be an economical alternative to the use of large "throw away" launchers like the Saturn.

The fortunes of NASA's authorizing legislation, the "Space Act," reflects a similar diminished priority for a great national adventure in space as successive amendments stripped the statute of its originally well-focused declaration of purpose. In 1964, NASA's ten top executives lost their special pay status. In 1973, the National Aeronautics and Space Council, which could have served as a vehicle by which the executive branch crafted an interagency consensus around a well-defined program, was abolished. From 1974 onward NASA's authorizing statute became burdened with numerous charges to the agency, occasionally having only the most tangential relation to NASA's

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[33] For one view of the decade, see Allen J. Matusow, *The Unraveling of America: A History of Liberalism in the 1960's* (New York: Harper and Row, 1984).

[34] Robert A. Divine, "Lyndon B. Johnson and the Politics of Space," in Robert A. Divine, ed., *The Johnson Years: Vietnam, the Environment, and Science*, Vol. II (Lawrence: University Press of Kansas, 1987), pp. 217-53.

[35] The last Apollo mission was the Apollo-Soyuz Test Project jointly conducted with the Soviet Union. An Apollo command and service module, equipped with a specially adapted docking module, joined with a Soyuz spacecraft in July 1975. The spacecraft spent two days docked together in orbit while American astronauts and Soviet cosmonauts ate and visited together and performed joint scientific investigations.

original purpose. At the same time, the addition of these new statutory directives reflected admiration for the agency's technical and managerial know-how. After all, "if NASA could send men to the Moon, why couldn't they also . . . ?" In 1974 NASA was directed to develop and demonstrate "solar heating and cooling technologies;" in 1975, to monitor and investigate the "chemical and physical integrity of the Earth's upper atmosphere"; in 1976, to develop "more energy efficient and petroleum conserving and environment preserving ground propulsion systems"; in 1976, to develop and demonstrate "electric and hybrid [ground] vehicle" technologies; and in 1978, to develop advanced automobile propulsion systems *and* to assist "in bioengineering research, development, and demonstration programs designed to alleviate and minimize the effects of disability." In the early 1980s NASA lost its privileged position as the United States' arbiter of non-military space activity, as the agency was denied authority to promulgate regulations for the granting of licenses for NASA patents and, in 1984, the agency acquired statutory direction to "seek and encourage to the maximum extent possible the fullest commercial use of space." By 1988 NASA found itself required to contract with industry for Expendable Launch Vehicle (ELV) services.[36]

As public support for the civilian space program remained soft,[37] the number of government employees NASA was able to support declined to about two-thirds (in 1988) of the almost 36,000 people on the NASA payroll in 1966.[38] Faced with deteriorating support, NASA executives had a legitimate desire to protect the field centers, whose most skilled technical employees were essential to the agency's ability to go about its work. By designating "roles and missions" for each of the centers, NASA attempted to avoid duplication and assure each installation essential functions related to the particular project work assigned to it.[39] The elaborate institutional machinery developed to carry out Apollo could not be so easily disassembled, however, given the interlocking interests it had created among NASA's installations, contractors, and geographic regions and their representatives in Washington.

And so the organization that built America's civil space program in the high noon of the Cold War groped about for a marketable mission. In 1971 Deputy Administrator George M. Low even contemplated recasting NASA as a national technology agency,

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[36] *National Aeronautics and Space Act of 1958, As Amended*, printed for the Use of the National Aeronautics and Space Administration, January 1990.

[37] As measured by NASA appropriations, which haven't recovered their 1965 level in constant dollars. See also "Towards a New Era in Space: Realigning Policies to New Realities," Committee on Space Policy, National Academy of Sciences and National Academy of Engineering (Washington, DC: National Academy Press, 1988).

[38] NASA contractor employees outnumbered civil servants 3 to 1 in the early 1960's, ballooned to 10 to 1 in 1966, and subsided to about 2 to 1 in the 1980's. Nimmen and Bruno with Rosholt, *NASA Historical Data Book*, 1:118, and *NASA Pocket Statistics* (Washington, DC: NASA, 1986), p. C-27. Numbers of current contractor employees can only be estimated.

[39] Associate Director for Center Operations, on "Catalog of NASA Center Roles," April 16, 1976. Part of the intent of the "roles and missions" concept may have been to reduce inter-center rivalry, but institutional specialization has apparently done little to relieve institutional particularism.

responsible not only for aeronautics and space research and development, but also for a wide range of "technological solutions" for national problems such as alternative power and energy sources, environmental pollution, improved transportation systems, health care systems, productivity of services, education, and housing.[40] That others were thinking in this vein as well is apparent from the non-aerospace responsibilities added to NASA's authorizing legislation during the 1970s.

NASA's civil servants and various advisory groups carried out periodic studies during subsequent years to define NASA's goals, or to articulate a vision, for the civil space program. There were, of course, those visionaries within the agency who had worked with NASA for decades and believed that if they tried harder the public could be persuaded not only to recognize the promise of an ambitious space program, but to pay for it. Such visionaries combined with bureaucratic entrepreneurs a decade later to persuade President Ronald Reagan in 1984 to pronounce his blessing on a program to design, build and operate a true Space Station—an orbiting U.S. outpost in space that had been a NASA dream since the agency was first established.[41]

A Space Transportation System

Meanwhile, during the 1970s the more pragmatically minded bowed to the budgetary pressures that had come to dominate Washington's political climate. In 1971 NASA persuaded the Nixon White House that the proposed shuttle program[42] would "take the astronomical costs out of astronautics."[43] The agency had contracted with an economic research firm to investigate the economics of the proposed shuttle system. The economists reported in 1971—on the basis of figures and formulas that had to have been somewhat speculative—that such a system would be economical *assuming* a flight rate of "between 300 and 360 shuttle flights in the 1979-1990 period, or about 25 to 30 space shuttle flights per year."[44] Even more portentous was what such a flight rate, in turn, assumed that NASA—its organizational strength rooted in its history as an advanced technology research and development organization—would be just as successful as the operator of a routine transportation system.

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[40] George M. Low, Deputy Administrator, NASA, Memorandum for the Administrator, "NASA as a Technology Agency," May 25, 1971, NASA Historical Reference Collection.

[41] Sylvia Doughty Fries, "2001 to 1994: Political Environment and the Design of NASA's Space Station System," *Technology and Culture* 29 (July 1988): 568-93.

[42] Properly referred to as the "Space Transportation System," i.e., the Shuttle Orbiter, External Tank (non-recoverable) and twin Solid Rocket Boosters.

[43] Statement by the President, the White House, January 5, 1972, NASA Historical Reference Collection.

[44] Mathematica, Inc. "Economic Analysis of the Space Shuttle System," National Aeronautics and Space Administration Contract NASW-2081 (January 1972), copy in NASA Historical Reference Collection.

NASA Deputy Administrator George M. Low acknowledged that the agency would have to change to operate a cost-effective space transportation system, though whether he grasped just how fundamental a change was involved is not clear. The cost of "doing business in space, coupled with limited and essentially fixed resources available for space exploration," observed Low to his senior management team, "places severe limitations on the amount of productive work that NASA can do, unless we can develop means to lower the unit cost of space operations." Low correctly attributed that "high cost" to the "great sophistication" with which most space systems are designed in order to "operate acceptably with low allowable weight" and to the fact that "most systems are individually tailored for their mission, used once or twice, and then never used again. Thus the economies of producing a number of like systems are never attained." NASA would now, asserted Low, have to abandon the strategy of developing "individually tailored technologies" and, instead, "focus on *multiple-use, standardized* systems" (emphasis added).[45] In 1983, with the shuttle's series of flight tests completed, the Congress added to the statutory activities in which NASA was authorized to engage "the *operation of a space transportation system* . . ." (emphasis added).

Although Low may not have thought of it in these terms, he was, in effect, asking the NASA organization to turn back the clock to a time when U.S. manufacturers evolved management strategies to achieve the efficiencies of standardized, volume production to exploit an expanding market. It was a bold risk that he was taking. To the extent that the nation's civil space program hinged on the success of the shuttle program, NASA would have to undertake the most profound reversal in its organizational culture that any organization could be asked to make. Would it succeed? Could the agency and its industrial partners unlearn the management strategies and habits they had had to learn in order to design and produce the complex and reliable aerospace systems that carried men to the Moon? Would NASA's inherited research culture be able to respond to the administrative and logistical demands of routine operational efficiency? And would an expanding market for space transportation support the need to divert scarce resources into the routine operation of "multiple-use, standardized systems?"

A partial answer came in the form of the report issued by the Presidential Commission on the space shuttle *Challenger* accident that had occurred January 28, 1986. Chaired by former Secretary of State William P. Rogers, the commission concluded that the fiery end of Mission 51-L was caused by "the failure of the pressure seal in the aft field joint of the right Solid Rocket Motor. The failure was due to a faulty design unacceptably sensitive to a number of factors. These factors were the effects of temperature, physical dimensions, the character of materials, the effects of reusability, processing, and the reaction of the joint to dynamic loading."[46] That was the *technical* cause. The commission was also impressed by other proximate causes of the accident to which it ultimately gave great weight: a top-level decision to launch that had been inadequately

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[45] George M. Low, Deputy Administrator, NASA, Memorandum to Addressees, "Space Vehicle Cost Improvement," May 16, 1972, NASA Historical Reference Collection.

[46] *Report of the Presidential Commission on the Space Shuttle Challenger Accident, Vol. I* (Washington, DC: U.S. Government Printing Office, June 6, 1986), p. 72.

informed about the sensitivity of the O-rings on the Solid Rocket Boosters' aft field joints to the inordinately cold temperatures prevailing at the time of the launch, a "silent" safety, reliability, and quality assurance program, *and* an organizational failure to adapt to the requirements of a truly operational transportation system. These included lack of schedule discipline and inadequate logistics to support the flight rate that would enable the agency to deliver the economies promised when President Ronald Reagan announced in 1982 that "the first priority of the STS program is to make the system fully operational and cost-effective in providing routine access to space."[47]

For the next two and a half years NASA redesigned known weaknesses in the shuttle's systems, elevated the status of the safety, reliability, and quality assurance organization, and tightened decision-making channels between its centers and headquarters. The result was a successful "return to flight" in September 1988. Wags remarked that the flight of STS-26 was probably the safest shuttle mission imaginable. Underlying management issues—especially whether NASA could, or even should, attempt to transform itself into an operations organization—proved more stubborn. When the agency undertook an assessment of its "management practices and . . . the effectiveness of the NASA organization," it turned for help to one of its most respected *program managers*, General Phillips.

Not surprisingly, the Phillips group, which reported back to NASA in December 1986, recommended (among other things) stronger program management, to be achieved through "strong headquarters program direction for each major NASA program, with clear assignment of responsibilities to the NASA centers involved," and improved "discipline and responsiveness to problems of the program management system." At the same time, the group insisted "NASA must accept that it will be responsible for spaceflight operations for the foreseeable future." That NASA had not, to that point, fully accepted its operational responsibility was suggested by the fact that the agency's "present structure of organization and management does not assure adequate attention to operations requirements in system design or in the planning and conduct of operations and logistic support in the era of frequent shuttle flights and long-term operation of the space station."

To buttress the agency's ability to meet the operational needs of the shuttle program, the Phillips group called for the creation of a new Associate Administrator for Operations, whose organization would include space tracking network and data systems and—eventually—the Kennedy Space Center. Two years later NASA did create an associate administrator level Office of Space Operations, but it was not clear whether the new organization was merely old wine (the former Office of Space Tracking and Data Systems) in a new bottle. The competing demands of operations and research and development continued to trouble the agency whenever (as in 1990 and early 1991) its heightened safety procedures detected problems with shuttle hardware requiring protracted "stand downs" of one or more shuttle spacecraft.

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[47] Quoted in *ibid.*, p. 164.

Compromise

Underscoring the uncertainty of NASA's mission and its standing within the constellation of Federal programs, President George H. Bush reestablished in April 1989 an interagency policy council for the nation's space activities when he created the National Space Council, chaired by the Vice President. Through the Advisory Committee on the Future of the U.S. Space Program, established in 1990 under the auspices of NASA and the Council, a consensus emerged that NASA's primary business should continue to be what it had been in the 1960s—the scientific exploration of space and aerospace research and development. Asserting that "perfection" should be the single most important aim for NASA's organizational culture, the "Augustine Committee," informally named for its chairman, Norman R. Augustine, Chairman and CEO of the Martin Marietta Corporation, explained:

> . . . perfection can most closely be approached in an organization whose ethos is one of excellence and where this ethos permeates everything it does. . . . It must be clear to all that, in this culture, *excellence is more important than schedule and more important than cost—even though these too are important*—and that management at all levels can be reliably counted upon to act with this as its set of values (emphasis added).[48]

At the same time, the committee recognized that, so long as NASA was responsible for the shuttle, the agency would have to adapt to the demands of a successful operating organization. The comments of many who spoke with the committee "frequently referred to the consuming effect this [flight operations] responsibility can have on NASA's senior management, limiting the time available for the planning and direction of leading-edge technological developments." Committee witnesses also expressed the belief that "the merging of operations into a largely developmental organization does not foster the building of a professional operations cadre which can best manage this vital responsibility."[49]

The committee added a refinement to the issue that had been provided by a 1988 National Academy of Public Administration (NAPA) study, also led by Phillips, of NASA Headquarters management. The NAPA study did not fault NASA for its weaknesses in operations management. Rather, it argued,

> the term 'operational' as applied to commercial aircraft, to ships, or to mass-produced articles of defense will most likely never apply to space systems in that same context. What we do see, however, are large, complex space systems such as the Shuttle and the Space Station that are or will be largely driven by operational issues—turnaround time between flights, manifesting, retrofitting of design changes for safety, cost or payload capability purposes, logistics, training of basic and science crew members, and so on. These are not the basic work of research and development

[48] *Report of the Advisory Committee on the Future of the U.S. Space Program* (Washington, DC: U.S. Government Printing Office, December 1990), p. 16.

[49] *Ibid.*, p. 38.

> leading to new concepts and ideas for future space systems, nor for expanding knowledge of the universe and discerning the implications of that knowledge for life on this planet or elsewhere.[50]

The NAPA report supported the earlier Phillips report recommendations, and what the Augustine committee would recommend: "an organizational separation, from the top of the agency down, on the two matters of space flight operations and space system development." A new Associate Administrator position for Space Flight Operations should be established, whose responsibilities should include space shuttle operations, ELV (expendable launch vehicle) operations, and the Tracking and Data Systems organization. To this individual should then be given the formidable task of "injecting operational requirements into new programs to assure that they can be effectively operated over their lifetimes at reasonable cost."[51] Just what leverage this individual would have at budget time over the prevailing research and development culture of the agency, the committee did not say. Shuttle operations themselves, however, might be less likely to receive short shrift, added the committee, if responsibility for the space shuttle was "eventually moved from a development oriented center [viz., Johnson Space Center] to the operationally oriented Kennedy Space Center." What NASA should strive for, urged the committee, is "safe operation [of the Shuttle], performed as efficiently and routinely as its complexity permits, and not burdened by excessive layers of management that are the legacy of the development era and recovery from the Challenger accident."[52]

And so, a compromise was struck. NASA should retain its identity and role as a research and development organization, the identity with which most of its people were comfortable and upon which its self-esteem depended, and it would not have to lose its most visible achievement—the shuttle—to do so. Suggestions that space shuttle operations be transferred to some other, and perhaps especially created, government entity, or to the private sector, had been rejected. But some significant portion of the organization would have to learn how to operate a transportation system. Whether the Congress, or NASA's internal budgetary politics, would yield the wherewithal to do so, remained to be seen.

How effectively an organization imbued with the values and habits of a research and development mission could adapt to the requirements of efficient and cost-effective operation of a space transportation system was (setting aside perennial funding issues) one of the two principal issues facing the NASA organization at the beginning of the 1990s. The other was an old issue, one that could be traced back to the 1950s: the wisdom and consequences of the Federal government's policy of "contracting out" for the bulk of its research and development work as well as for supplies and services.

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[50] National Academy of Public Administration. Samuel C. Phillips, Chairman, *Effectiveness of NASA Headquarters: A Report for the National Aeronautics and Space Administration*, February 1988. Quoted in *Report of the Advisory Committee*, p. 38.

[51] *Report of the Advisory Committee*, p. 38.

[52] *Ibid.*, p. 40.

In the spring of 1990, NASA's administrator asked the National Academy of Public Administration to revisit that question for NASA. The NAPA study, completed in January 1991, found still valid the 1962 Bell Report's guideline for what, and what should not, be contracted out. The government should not contract out

> decisions on what work is to be done, what objectives are to be set for the work, what time period and what costs are to be associated with the work, what the results are expected to be, and the evaluation, and the responsibilities for knowing whether the work has gone as it was supposed to go, and if it has not, what went wrong, and why, and how can it be corrected.[53]

Having surveyed, with interviews and questionnaires, over 2,000 NASA scientists and engineers, the NAPA study team concluded that contracting out had indeed led to an erosion of strength among NASA's civil service scientists and engineers. Critics argued that that was a predictable conclusion, given the persons surveyed. It then proceeded to develop recommendations most of which called on NASA's top management to provide better scrutiny of, and clearer guidelines for, the kinds of activities being contracted to the private sector. The context for these recommendations was the NAPA group's finding that "hands-on science and engineering work experience is essential to developing scientists and engineers with a level of knowledge that provides a sixth sense for spotting problems early, for being a smart buyer of technical products and services, and for being astute overseers of the work of technical contractors" and that NASA was not providing enough opportunities for this kind of work.[54]

The Augustine Committee, for its part, agreed that "an appropriate balance between in-house and external activity also should be developed." But this group saw the balance differently. In the more than three decades that had passed since NASA was created, there had developed a solid basis of space technology skills in both industry and academia; it was no longer necessary for NASA to match every development being contracted with comparable in-house laboratory skills. Citing the recent experience of national security aerospace R&D procurement, the committee argued that NASA could "buy smart" with fewer civil service project and program personnel. "NASA should concentrate its 'hands-on' expertise," the committee recommended, "in those areas unique to its mission, and avoid the excessive diversion of technical or mission specialists to functions which could be performed elsewhere. Contract monitoring is best accomplished by a cadre of professional systems managers with appropriate experience. Increased use of performance requirements, rather than design specifications, will further increase the effectiveness of this approach."[55]

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[53] Quoted in National Academy of Public Administration, *Maintaining the Program Balance: The Distribution of NASA Science and Engineering Work Between NASA and Contractors and the Effect on NASA's In-House Technical Capability*, 2 vols. (Washington, DC: National Academy of Public Administration, January 1991), 1:6.

[54] *Maintaining the Program Balance*, 1:x.

[55] *Report of the Advisory Committee*, pp. 40-41.

The Augustine committee also called for more competitive government salaries for scientists and engineers, "pay for performance," and making full use of existing flexibility within the government's personnel system. NASA should be a "pathfinding" agency for the development of an "advanced" Federal personnel system that would reward excellence and special skills over seniority and generic tasks. Should NASA fail to persuade the Office of Personnel Management to allow the agency to revamp its personnel system, NASA might convert additional centers to federally funded research and development centers affiliated with major universities.[56] Whether NASA would succeed remains to be seen. Even if NASA were able to increase the number of high-caliber scientists and engineers within its ranks, would the practice of contracting out most of the agency's research and development work—leaving its own people to function as contract monitors—undermine its gains?

Conclusion

NASA's ongoing struggle to maintain its organizational momentum in the face of seemingly insuperable obstacles—public uncertainty, as well as its own, as to its overarching purpose; the constraining tendencies of Federal regulations designed to keep political, bureaucratic and technical power in check; and the need, time after time, to plead for funds and justify itself—is worth understanding not only because of what the agency does, but for what it represents. One obstacle NASA could not escape was the need to develop a large organization to carry out its work. That organization would perforce become a Federal bureaucracy.

A creative bureaucracy seems to most a contradiction in terms. We rightly understand that the essence of a bureaucracy is depersonalized routine. Indeed, bureaucracies came into being so that the execution of laws and regulations in emerging nation-states might become less arbitrary, less capricious, and more accountable than it had been under personalized monarchical rule. No modern society with any aspiration to democracy would countenance surrendering its resources and destiny to a handful of solitary dreamers, however enticing the dream. Thus "organizing for exploration" was and remains the challenge facing the United States if it would venture across the frontier of outer space. The fact that managing the organization created to conduct that journey has proven difficult is less a sign of the failings of the travelers—though being human they have had failings enough—than a sign of the enormity of their task.

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[56] *Ibid.*, pp. 40-42.

Chapter 6

Space Policy-Making in the White House: The Early Years of the National Aeronautics and Space Council

Dwayne A. Day[1]

Sputnik I really came as no surprise to the Eisenhower administration. Eisenhower had been receiving fairly reliable intelligence that the Soviet Union was about to launch a satellite into Earth orbit for some time. But Sputnik I and Sputnik II created a near crisis atmosphere in the United States and were used to dramatic political advantage by Senate Majority Leader Lyndon Johnson. In Sputnik's aftermath, the National Aeronautics and Space Council (NASC), a White House policy advisory group, was created as part of the same National Aeronautics and Space Act that established NASA. Opposed by Eisenhower, the NASC was created out of Lyndon Johnson's desire that space policy issues receive presidential attention. By creating an advisory board that reported to the president directly, it was hoped that the country would never suffer another space "surprise" like Sputnik. But despite this goal, the NASC played only a minimal role in the formulation of American space policy for most of its fifteen year existence. Its limited influence reflected a fundamental fact of executive branch politics: an advisory council is only as powerful as the president wishes it to be. Furthermore, lacking strong presi-

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dential support, such an organization is likely to become embroiled in turf battles with those agencies charged with actually carrying out the policies. Except for a brief period in 1961 and again in 1963, the NASC failed to receive the attention from Presidents Eisenhower, Kennedy, Johnson and Nixon that was necessary in order to give it a major role in the formulation of space policy.[2]

The Creation of the National Aeronautics and Space Council

Senator Lyndon Johnson is generally considered to be responsible for the idea of a National Aeronautics and Space Council.[3] His intention was to keep a strong emphasis on both military and civilian space programs and to provide a mechanism for ensuring that major space issues would not be overlooked by either NASA or the Department of Defense.[4] Johnson made this argument in Senate hearings as chair of the Senate Special Committee on Space and Astronautics after the Soviet Sputnik launch. During this period he turned the issue of U.S. leadership in space as well as general science and technology to political advantage. He also acquired a skilled knowledge of space policy issues which later served him well as chairman of the NASC.

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[2] Until December 1993, large parts of the official NASC papers contained at the National Archives, particularly the Minutes, were not available for general public viewing because they also contained classified records. The total amount of the collection that was classified was approximately 12 percent. Virtually all of the minutes of these early meetings of the NASC were declassified at the author's request and are now available to researchers. Still-classified records have been removed from the collection and are stored separately.

In the mid-1980s, the issue of a National Space Council arose again as a Democratic Congress sought to impose a policy-making agency on the Executive Branch. The lessons of the earlier Council's ineffectiveness and ultimate demise were ignored at this time, as well as during the debate over the elimination of the Council by President Clinton in 1993. The activities of the National Space Council during the Bush Presidency, as well as the other space policy-making bodies which followed the abolition of the NASC in 1973, are beyond the purview of this paper. I hope to address them in a future paper. For now, I will note that President Bush, for a number of reasons, gave the National Space Council greater authority and attention than the NASC had for most of its existence. This, in part, reflects the reasons why disputes between the Space Council and NASA were more vitriolic than those between the NASC and NASA.

[3] Robert L. Rosholt, *An Administrative History of NASA, 1958-1963* (Washington, DC: NASA SP-4101, 1966), pp. 13-14.

[4] *The National Aeronautics and Space Council During the Tenure of Lyndon B. Johnson as Vice President and During His Administration as President (January 1961-January 1969)*, December 26, 1968, p. 1. (hereafter referred to as the "History of The NASC from January 1961-January 1969"), "NASC" File, NASA Historical Reference Collection, NASA History Office, NASA Headquarters, Washington, DC. This overview of the NASC was written by its Executive Secretary, Edward Welsh, shortly before he left his position. A classified copy was removed from the NARA files. However, John M. Logsdon was provided a copy by Welsh nearly twenty years ago. The only portions removed from this document by Welsh were apparently proprietary and not classified information. Copies are now available at the NASA Historical Reference Collection, the Space Policy Institute, and in the finding guide for the National Archives NASC collection.

The problem with Johnson's vision was that it ran counter to Eisenhower's own approach to handling the situation. Eisenhower did not view Sputnik as a crisis, and had access to far better information on the state of the Soviet and American space programs than his critics. In the wake of Sputnik, Eisenhower consulted both with Alan Waterman, director of the National Science Foundation, and with numerous scientists outside the government.

Sputnik was launched on October 4, 1957. On October 15 Eisenhower met with the Office of Defense Management Science Advisory Committee (ODM-SAC). In a wide-ranging discussion, Eisenhower asked for the Committee's advice. At the close of the meeting, the chairman of the Committee, I.I. Rabi, recommended that Eisenhower appoint a science adviser. James Killian, also a member of ODM-SAC, further recommended that this science adviser be backed up by a committee. Eisenhower felt that both ideas had merit and proposed that the ODM-SAC meet with the Secretary of Defense. Several other meetings ensued and both recommendations were implemented. Killian had previously been appointed as Science Advisor and this was announced by Eisenhower in a radio address to the nation on November 7, 1957.[5]

This was a significant development in the history of science policy. For the first time, a scientist had key access to the White House. Killian quickly created the President's Science Advisory Committee (PSAC), which was given wide latitude in surveying all aspects of American science and technology, including military issues, education, and space. But despite Killian and PSAC's expansive purview, the popular press quickly labeled Killian the "missile czar," and focused on his role in the American space program. Killian managed to increase the priority of the United State's fledgling IGY Scientific Satellite Program, achieving for both it and other national security space programs "Highest National Priority," early in 1958.[6] Throughout the remainder of the Eisenhower administration, PSAC would play a continuing role in advising the president on space issues.

The Eisenhower administration had the Bureau of the Budget send legislation to the Congress on April 2, 1958, outlining its proposals for what eventually became the National Aeronautics and Space Act. The main part of the legislation was a proposal to create a National Aeronautics and Space Agency primarily from the National Advisory Committee on Aeronautics.[7] This legislation included provisions for a National Aeronautics and Space Policy Board. The Board was to meet at least quarterly and consist of no more than 17 members serving without compensation. The Board would provide advice on space issues to both the president and the NASA Director and make recommendations to NASA on policies, programs, budgetary matters and major appointments. Senators Johnson and Bridges introduced the bill as S.3609 on April 14 in the Senate and Congressman McCormack and several others introduced the bill in the House as HR

[5] James R. Killian, Jr., *Sputnik, Scientists, and Eisenhower* (Cambridge, MA: MIT Press, 1982), pp. 12-26.

[6] NSC Action Number 1846, "Priority for Ballistic Missiles and Satellite Programs," January 22, 1958, NASA Historical Reference Collection.

[7] This proposal was later changed to the National Aeronautics and Space Administration.

11881.[8] Both the House and Senate bills were rewritten over the next two months and on June 11 the Senate committee reported the bill out and it was passed on June 16. This bill established a Space Policy Board with a paid staff to replace the 17 member advisory board in the administration's bill.[9]

The White House opposed provisions for the Policy Board, arguing that it usurped the authority of the president. According to Killian, those who had drafted the original bill in the White House were strongly opposed to the idea. Eisenhower thought that it would be too powerful and that space was not, and would not become, so important that it would warrant such a body.[10] Leaders in the House of Representatives agreed with the president and it was virtually certain that the bill would not pass unless the language was changed. Johnson, serving as Senate Majority Leader and chairman of the Special Committee on Space and Astronautics met with Eisenhower at the White House. Johnson stated in his memoirs that Eisenhower "was afraid that in its advisory capacity to the President the Council might make too many demands upon the President and even try to dictate policy to him." To avoid that possibility, Johnson proposed that the President should be the chairman of the Policy Board.[11] Eisenhower agreed and a week later, on July 15, the House and Senate conference committees met and agreed to the changes in the policy board while changing its name to the National Aeronautics and Space Council.[12]

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[8] The Space Policy Institute, "The Legislative Origins of the Space Act," Proceedings of a Videotaped Workshop, April 3, 1992, Appendix, see especially Glen P. Wilson, "How the U.S. Space Act Came to Be," p. 70.

[9] *Ibid.*, p. 71.

[10] Killian, *Sputnik, Scientists, and Eisenhower*, p. 137.

[11] Johnson claims that he was the one who initiated the compromise meeting with Eisenhower. See Lyndon Baines Johnson, *The Vantage Point: Perspectives of the Presidency, 1963-69* (New York: Holt, Rinehart and Winston, 1971), p. 277. Robert A. Divine indicates that Eisenhower initiated the meeting and proposed the compromise. See Robert A. Divine, *The Sputnik Challenge: Eisenhower's Reponse to the Soviet Satellite* (New York: Oxford University Press, 1993), p. 147. Divine's conclusion seems to be based in part on a memorandum for the record made by Deputy Assistant to the President, Wilton B. Persons, who recounted a telephone call Eisenhower placed to him immediately after the meeting in which he stated, "They had specifically agreed upon the President's proposal of modeling the advisory group along the lines of the National Security Council: that the authority would be placed with the President and that he would have an advisory group of some eight staff members, at least three of whom would come from outside the Federal Government. Senator Johnson accepted this concept and agreed to work for its inclusion in the bill." Wilton B. Persons, Memorandum for Record, "Off-The-Record Meeting - 6:00 p.m., The Mansion, Monday, July 7, 1958, The President, Senator Lyndon Johnson, (Just the Two)," July 7, 1958, Dwight D. Eisenhower Diary, Box 35, Dwight D. Eisenhower Library, Abilene, KS.

[12] "The Legislative Origins of the Space Act," Proceedings of a Videotaped Workshop, April 3, 1992, Appendix, Glen P. Wilson, "How the U.S. Space Act Came to Be," p. 71.

Killian's comments on the compromise are particularly interesting. While accepting the account presented in Johnson's memoirs, Killian stated that Eisenhower "reported to me almost apologetically that he had agreed that a space council under presidential chairmanship could be included in the Space Act and that he had done so in order to see the bill move ahead." See Killian, *Sputnik, Scientists, and Eisenhower*, p. 138.

The National Aeronautics and Space Council as established by the National Aeronautics and Space Act of 1958 was significantly different than what Eisenhower had originally proposed. In the words of the Act the Council was supposed: ". . . to advise and assist the President, as he may request, with respect to the performance of functions in the aeronautics and space field."[13] The functions of the Council included: surveying significant aeronautical and space activities of NASA and the Department of Defense, developing a comprehensive program of aeronautical and space activities, designating responsibility for the direction of such activities, and providing for effective cooperation and resolving differences between NASA and DOD. The Council was to be chaired by the president and include the Secretaries of State and Defense, the Administrator of NASA, the Chair of the Atomic Energy Commission and an additional government member and three civilian scientific members to be appointed by the president. The Act also provided for an Executive Secretary of the Council who would be appointed by the president and confirmed by the Senate. The executive secretary was given the power to hire a staff.[14] This last point, although apparently insignificant, is meaningful in bureaucratic terms for it signifies that the organization was consequential enough to have paid individuals working for it—that a formal executive secretary was never appointed under Eisenhower and no formal paid employees were hired to work on it indicates the low regard that Eisenhower held for the NASC.

For almost ten months, American space policy had been addressed by Killian and PSAC. The NASC was now supposed to assume this role. But Eisenhower was comfortable with Killian and the scientist enjoyed easy access to the Oval Office. President Eisenhower, who had originally viewed the policy board as a temporary and weak organization and only reluctantly accepted its final form, did not appoint a permanent executive secretary to the NASC. Robert O. Piland, who served in the Office of the Special Assistant for Science and Technology at NASA, became the first Acting Executive Secretary of the Council. He served in this capacity until January 1959, when NASA Administrator T. Keith Glennan appointed his special assistant Franklyn W. Phillips to take over.[15] Since Piland and Phillips were Acting Executive Secretary's, both lacked the power to appoint a staff and relied instead upon support from both NASA and the Department of Defense.[16]

NASA was officially created in August 1958, but did not begin operating until October 1, 1958. In early September, NASA Administrator T. Keith Glennan and Presidential Science Advisor James Killian decided that the NASC should meet. During this time, PSAC had been overseeing American space policy for the president. Glennan

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[13] Title II—Coordination of Aeronautical and Space Activities, National Aeronautics and Space Council, Sec. 201 (e), National Aeronautics and Space Act of 1958, 72 Stat. 427: 42 U.S.C. 2471, July 29, 1958.

[14] "History of The NASC from January 1961-January 1969," p. 2.

[15] *Preliminary Inventory of the Records of the National Aeronautics and Space Council,* Record Group 220, Compiled by Jarritus Wolfinger, National Archives and Records Service, Washington, DC, 1977, Introduction, p. 1.

[16] *Ibid.*

Figure 1 Meeting of the National Aeronautics and Space Council at NASA's Ames Research Center outside San Francisco on August 3, 1959. Listening to a briefing on a research project is: (Front Row, Left to Right) Ames director Smith DeFrance; John T. Rettalianta; Franklyn W. Phillips, Council Executive Secretary; T. Keith Glennan; and Alan T. Waterman. Photograph from NASA collections, no. A-25521-B.

talked with Killian and both decided that Killian would prepare an agenda for the meeting and a procedure for discussing items on the agenda.[17] On September 12, an overview of the U.S. space program was prepared and distributed to members of the Council. Titled, "National Space Activities: A Brief Summary," and stamped "Secret," it detailed all of the various agencies involved in space research as well as the programs that they had under development.[18] It included not only NASA's space science program, but also the joint Advanced Research Projects Agency-Air Force Ballistic Missile Division WS-117L reconnaissance satellite system then scheduled to begin testing in the fall of

[17] J.D. Hunley, ed., *The Birth of NASA: The Diary of T. Keith Glennan* (Washington, DC: NASA SP-4105, 1993), p. 7.

[18] "National Space Activities: A Brief Summary," September 12, 1958, contained in folder: "NASC Mtg. Sept. 24, 1958 (1st Mtg.)," *Records of the National Aeronautics and Space Council*, Record Group 220, Box 1, National Archives and Records Administration.

1959.[19] The briefing did not include the highly classified CIA-Air Force CORONA satellite project which had been split off from WS-117L in February.

On September 23, Killian and Glennan briefed Eisenhower on the issues and the agenda. Eisenhower decided at this time that Glennan should present the agenda at the meeting, something that the NASA administrator was not prepared for and which caused him much worry.[20] However, the first meeting on September 24 was apparently uneventful. At the meeting, Eisenhower stated "I shall look to this Council for advice on the broad policy aspects of our national aeronautics and space program." It was proposed and accepted that the group would meet once a month rather than the weekly meetings of the National Security Council on which the NASC was modeled.[21] From very early on a pattern was developed for these meetings: the meetings would alternate between informal briefings of most of the members of the Council and full meetings with the President serving as chair. This first meeting also addressed a new large rocket booster program being undertaken by Wernher von Braun's team at Huntsville, Alabama.

Around this time, Glennan had come to the conclusion that von Braun's rocket team at the Army Ballistic Missile Agency (ABMA) in Huntsville should be incorporated into NASA.[22] This decision was not popular with the Army, which saw von Braun's team as its primary means of maintaining a ballistic missile capability equal to that of the Air Force. At the first meeting of the NASC, Eisenhower advocated transferring this large booster program to NASA. But he agreed that NASA and the Army should negotiate this on their own and the NASC would not get involved unless there was a stalemate.[23] An October 29 meeting of the Council also failed to settle the dispute.

In November, the Army proposed transferring the Jet Propulsion Laboratory to NASA at the beginning of the year. Glennan agreed to this and discussed it with Eisenhower at a December 3 meeting of the Council. Eisenhower signed Executive Order 10793, which approved the transfer, on the same day. Eisenhower stated at the time that he thought Glennan's decision not to immediately transfer the ABMA to NASA was a mistake, but Glennan knew there was a great deal of opposition in the Army to this move and Eisenhower was willing to allow the Huntsville operation to remain under Army control for another year. However, although the Army would maintain control, NASA would assume funding and oversight of the large booster project which eventually became known as Saturn. At this same meeting, the topic of highest priority for Project Mercury also was addressed. NASA advocated that the program be given such

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[19] Hunley, ed., *Birth of NASA*, p. 6.

[20] *Ibid.*, p. 8.

[21] Divine, *Sputnik Challenge*, p. 187.

[22] Hunley, ed., *Birth of NASA*, p. 9.

[23] Divine, *Sputnik Challenge*, p. 187.

high priority and that its funding requirements and schedule, as reflected by this priority, also be approved.[24] NASA stated that this was not a crash program, but also stated that the CIA had noted that the U.S.S.R. was placing a great deal of effort on manned space flight. Eisenhower expressed some reservations, but the Space Council approved the recommendation.

In addition to his fight with the Army over the ABMA, Glennan also ran into other problems in Congress with Senator Stuart Symington, who chaired the Senate Space Committee's Subcommittee on Governmental Organization. On January 16, 1959, Symington queried him about the meetings of the NASC. Glennan gave him the dates of the meetings, but invoked the president's right to executive privilege to refuse to reveal the details of the meetings. Glennan said that he would discuss the possibility of setting aside executive privilege of Council deliberations with the president. He agreed that he had provided similar information on the issues in which the subcommittee was interested in two previous congressional appearances, but stated that that had been a mistake and that he had to stand firm. Two weeks later he sent a letter to Symington informing him that the president had insisted on executive privilege for Council deliberations.[25] The subcommittee, without knowing what the activities of the Council were, urged the administration to improve its effectiveness.[26] Glennan faced the same situation a year later in the House Committee on Science and Astronautics.[27]

During its first year and a half of existence, the NASC held bimonthly informal briefings for most of its members, alternating with meetings of the full Council which included the president in his capacity as chair. Throughout 1959, the Council continued to meet, but did little more than discuss issues. Glennan pressed the Department of Defense on his own to transfer the ABMA to NASA and was ultimately successful. The National Security Council also was drafting a revised "U.S. Policy on Outer Space" position paper and consulted with the NASC.[28] NASA's Office of Program Planning

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[24] "Minutes of meeting of the NASC on December 3, 1958," contained in folder: "NASC Mtg. Dec. 3, 1958 (3rd Mtg.)," *Records of the National Aeronautics and Space Council*, Record Group 220, Box 1, National Archives and Records Administration.

[25] Rosholt, *Administrative History of NASA*, p. 98.

[26] *Ibid.*, p. 99.

[27] Hunley, ed., *Birth of NASA*, p. 18.

[28] This statement replaced the policy statements contained in National Security Council documents NSC 5520 and NSC 5814/1. It was originally circulated as a draft document containing a National Security Council designation (NSC 5918), the approved statement was issued as a NASC document titled "U.S. Policy on Outer Space." It was approved in the final Eisenhower NASC meeting on January 12 and signed by the President on January 26, 1960. Although many of the members of the NASC, such as Defense, also served in the National Security Council, it is important to note that Eisenhower treated his formal statement of policy goals in space as a National Security Council issue and not as an NASC issue until the very end. Parts of this document remain classified and are currently awaiting Freedom of Information Act review request for the author.

and Evaluation was also developing a long-range plan and this too was discussed in NASC meetings.[29] But the NASC itself had virtually no input into policy formation.

By early January 1960, it was clear that Eisenhower wanted to amend the Space Act and one of his recommendations was to eliminate the Council. Glennan discussed the issue with Franklyn Phillips, Acting Executive Secretary of the Council, and proposed that Phillips work directly for him after the Council was eliminated.[30] Glennan also met with George Kistiakowsky, Killian's designated replacement as Science Advisor and also a member of PSAC, on Sunday morning, January 10, to discuss the upcoming final meeting of the NASC. He then met with Eisenhower on Monday morning to discuss changes to the Space Act. Eisenhower was particularly intent that the revised law did not include any advisory or coordinating committees, something he had opposed in the first Space Act a year and a half before.[31] Glennan then discussed several other items with the president, including the assignment of highest national priority for the Saturn booster program and the allocation of an additional $100 million to accelerate it. Glennan's impression at the time was that the matter was a "shoo-in."

The next morning, the NASC met without the president and went over various issues to be discussed in the afternoon. Shortly before noon, Glennan was called to meet with the president to discuss the additional $100 million that he wanted appropriated for the Saturn program. He was assured that the meeting was only to discuss process, and that the money was secure. But as Glennan later related in his diary, "The president started off by saying he was pretty well fed up with people coming in and asking for more money. He says here you come and bother [me] about $100 million while I'm trying to solve the problems of the world with $50 billion. He said he was quite certain that we were going to have to spend an extra $100 million on Saturn during the course of the spring, and he thought it ought to be settled at once." He did not like spending the money, but neither did he like being bothered about the issue.[32]

In the afternoon, the last meeting of the NASC in the Eisenhower administration was held. This was a joint meeting with the National Security Council, and most of the country's top national security officials were present.[33] The meeting started with a pres-

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[29] Office of Program Planning and Evaluation, NASA, "The Long Range Plan of the National Aeronautics and Space Administration," December 16, 1959, contained in "White House Files," NASA Historical Reference Collection.

[30] Hunley, ed., *Birth of NASA*, p. 33. Phillips then became one of Glennan's closest and most important advisors.

[31] *Ibid.*, pp. 40-41.

[32] *Ibid.*, p. 44.

[33] Among those in attendance were: Eisenhower; Vice President Nixon; UN Ambassador Henry Cabot Lodge; Secretary of the Treasury Robert Anderson; Under Secretary of State Livingston Merchant; Director of Central Intelligence Allen Dulles; Special Assistant to the President for National Security Affairs Gordon Gray; Chairman of the Atomic Energy Commission John McCone; Director of the Bureau of the Budget Maurice Stans; Deputy Secretary of Defense James Douglas; Chairman of the Joint Chiefs of Staff General Nathan Twining, and a number of others. Although many of those present were regularly invited to NASC meetings, it was rare that they were all in attendance.

entation by Donald Ling on the relative positions of the U.S. and Soviet space programs, which concluded that the Soviets would maintain their lead in rocket technology for two more years. The participants then proceeded to a discussion of the NSC position paper on national space policy which had been circulated as NSC 5918. The policy paper was approved at the session and signed two weeks later as an NASC, *not* NSC, document. Next on the agenda was NASA's long-range plan. Because it contained budget and planning figures for the nation's space program at a time when the United States was engaged in vigorous competition with the Soviet Union, it was labeled "Secret." This was also delivered without much comment despite the fact that it would lead to a NASA budget of approximately $1.6 billion by 1968. Glennan then called for the consideration of highest national priority for the Saturn program and Eisenhower agreed with little discussion. Then Eisenhower announced that he felt that the NASC had achieved its purpose and indicated that he and Glennan had discussed changing the law and eliminating the Council. He left it to Glennan to discuss the issue with the Council members.[34] This was the first that some of the members of the NASC had heard of the decision to eliminate the organization, but it was not totally unexpected. The fact that both the "U.S. Policy on Space" and NASA's long-range plan had been drawn up outside the NASC and not debated within it—NASC meetings had primarily been used to inform members of the proceedings, not to engage in policy-making—had been a clear indication to those present of the organization's place in the hierarchy. The National Aeronautics and Space Council did not meet again during Eisenhower's tenure. Instead, space issues were handled either in PSAC, NASA, or the NSC—where Eisenhower had wanted them addressed all along.[35]

Eisenhower never viewed the Council as anything other than a transitional body. By 1960, with the majority of mission, facility, and personnel transfers to NASA complete, Eisenhower viewed the Council's functions as essentially finished and advised that it be abolished. Eisenhower sent a message to Congress recommending several changes to the National Aeronautics and Space Act of 1958. Among them was the recommendation that the NASC be abolished. Eisenhower's philosophy about how space issues should be addressed is stated in his message,

> . . . there is inherent in it (the Act) the concept—which I believe to be incorrect—of a single "comprehensive program" of space activities embracing both civilian and military activities, and it implies that a multiplicity of unnamed agencies might have responsibility for portions of such a program.

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[34] *Ibid.*, pp. 43-45.

[35] One major example of the changing nature of the American space program was the creation of the Office of Missile and Satellite Systems, the predecessor to the National Reconnaissance Office, after meetings of the NSC, on August 25, 1960. This joint Air Force-CIA office which controlled the budding reconnaissance program essentially split the nation's space effort into three almost entirely separate programs: civilian, military and intelligence. By early to mid 1961, the NRO was virtually an entirely independent agency and one of the most highly guarded secrets in the country. It participated in some NASC briefings throughout the sixties, but was largely independent of its oversight. See Jeffrey Richelson, *America's Secret Eyes in Space* (New York: Harper and Row, 1990).

> . . . First, Section 201 (e) of the Act imposes upon the President an unusual degree of personal responsibility for developing this "comprehensive" space program and of surveying its operations in detail.
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> I have become convinced by the experience of the fifteen months since NASA was established that the Act needs to be amended so as to place responsibility directly and unequivocally in one agency, NASA, for planning and managing a national program of nonmilitary space activities. This requires, first of all, elimination of those provisions which reflect the concept of a single program embracing military as well as nonmilitary space activities. In actual practice, a single civil-military program does not exist and is in fact unattainable; and the statutory concept of such a program has caused confusion. The military utilization of space, and the research and development effort directed toward that end, are integral parts of the total defense program of the United States. Space projects in the Department of Defense are undertaken only to meet military requirements. The Department of Defense has ample authority outside the National Aeronautics and Space Act of 1958 to conduct research and development work on space-related weapons systems and to utilize space for defense purposes; and nothing in the Act should derogate from that authority.
>
> I am also convinced that it is no longer desirable to retain in the Act those provisions which impose duties of planning and detailed surveying upon the President. We have come to the end of a transitional period during which responsibilities for a broad range of activities were being shifted to NASA from the Department of Defense and NASA's capabilities for discharging those responsibilities were being developed. From now on it should be made clear that NASA, like the Department of Defense in the military field, is responsible in the first instance for the formulation and execution of its own program, subject, of course, to the authority and direction of the President.[36]

It is easy to understand Eisenhower's opposition to the Council. Eisenhower's three major space policy documents were drafted in the National Security Council. At the time that the NASC was created, Eisenhower already had his preferred mechanism for space policy advice—the President's Science Advisory Committee. Furthermore, not only would he have resented the intrusion of a legislative act of Congress into the president's powers to organize the Executive Branch, particularly the White House staff, as he saw fit, but it must also be remembered that the NASC grew out of a larger criticism of Eisenhower in Congress and the press. Many of the most vocal proponents of a Space Council had previously charged that Eisenhower's complacency and ineptness had led to Sputnik. From a Congressional standpoint, the need to bring informed information on the nation's space program directly to the president seemed to be imperative. But from Eisenhower's perspective, the space program had always been on the right track and many of the changes forced on him—the acceleration in defense, education, science and

[36] Dwight D. Eisenhower, "Special Message to the Congress Recommending Amendments to the National Aeronautics and Space Act," January 14, 1960, *Public Papers of the President: Dwight D. Eisenhower, 1960-1961* (Washington, D.C.: U.S. Government Printing Office, 1961), pp. 35-36.

space spending—were unnecessary and counterproductive.[37] Eisenhower wanted his space policy advice to come from NASA, PSAC and the NSC. The creation of the NASC never meant that it would be used, or that it would be used in the way its proponents intended.[38] Indeed, even after the NASC was created and had only met three times, it came under Congressional criticism. Eisenhower did not want the advice and he certainly did not want the criticism.

A Second Chance for the NASC

Shortly before assuming office, President-elect John F. Kennedy announced that he wanted his Vice President, Lyndon Johnson, to become chairman of the NASC.[39] Johnson, as Senate Majority Leader, had led hearings on Sputnik that were nationally televised and heavily covered in the press. Although it is popularly thought that Johnson convinced Kennedy that he should be chairman, the credit for the idea actually belongs with Richard E. Neustadt, who served as a consultant to the Kennedy transition team, and was recognized as a prominent expert on the presidency.[40] In a December 20, 1960, memorandum to Kennedy, Neustadt stated,

> Meanwhile, a NASA-Defense committee has been established. Experience to date suggests that this may be a promising development in securing coordination at the working level. It is unlikely to resolve the problems of securing policy advice. . . . An opportunity now exists to revitalize the National Aeronautics and Space Council under the Chairmanship of the Vice President.[41]

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[37] For two interesting perspectives on Eisenhower's response to Sputnik, see Divine's *Sputnik Crisis*, and Ken Hechler, "Commentary on the Reluctant Racer: Dwight D. Eisenhower and United States Space Policy," unpublished manuscript in the NASA Historical Reference Collection. It is also important to note that Eisenhower had access to information—most importantly the U-2 photo-reconnaissance missions that started in July 1956—that others did not and knew that many of the claims made about Soviet superiority were baseless. See, for instance, William F. Burrows, *Deep Black* (New York: Random House, 1986), or any of the recently declassified National Intelligence Estimates concerning the Soviet Union at the National Archives.

[38] Another creation of the Space Act which met with even less success than the NASC was the Civilian Military Liason Committee (CMLC) and was chaired by William Holaday, who was DOD Director of Guided Missiles.

[39] "History of The NASC from January 1961-January 1969," p. 3. See also *New York Times*, December 21, 1960, p. 1.

[40] Comments by Paul Dembling, "Roundtable Discussion," "The Legislative Origins of the Space Act," p. 55. This was the Aeronautics and Astronautics Coordinating Board (AACB), which replaced the CMLC, referred to above. The AACB proved far more capable than its predecessor at resolving *operational* disputes between NASA and the DOD. But it was not a policy board.

[41] Richard E. Neustadt, Memorandum for Senator Kennedy, "Memo on Space Problems for you to use with Lyndon Johnson," December 23, 1960, with attached: "Problems of Space Programs," December 20, 1960, contained in Documentary History Collection, Space Policy Institute, George Washington University. Document was given to the author by researcher Giles Alston, who obtained it from Richard Neustadt.

Neustadt was proposing that the NASC be used to experiment in the area of executive support and that it be given an advisory role instead of the informational one it assumed under Eisenhower.

Kennedy accepted Neustadt's recommendation concerning the chairmanship of the Council, but many other details remained to be worked out. Neustadt prepared an extensive memorandum on how the NASC should be organized and sent it to the president on February 27, 1961. Neustadt's stated assumptions were: that the president should have "top-level, politically responsible advice on policy (and follow through) that he can claim in other fields from a Cabinet Secretary"; that the vice president should not be asked to serve as "Secretary for Space," or that he be "cast in the role of a department head responsible for operations"; and that ". . . the Space Council should be conceived of not as an interagency committee, Eisenhower-style, but as a peg on which to hang a Kennedy-style staff unit."[42] Neustadt recommended that public members of the Council be eliminated and that it be kept small; that the executive secretary and his staff report directly to the chairman, not the Council collectively; and that the Council hold few, if any, formal meetings. The role of the Council overall was to advise the president on key issues; suggest other issues needing attention; monitor the implementation of the president's policy decisions by NASA and DOD; and "Act for the President and in his name, to the extent he wishes, as a source of policy direction and administrative guidance to NASA and Defense and other agencies concerned."[43]

Later, on February 28, 1961, Neustadt expressed his concern with "protecting the Vice President's position as a constitutional officer who cannot share, so should not be pressed to take operating responsibility." Neustadt continued, "But I recognize that Messrs. Kennedy and Johnson are breaking new ground in the evolution of the Vice Presidency, and that practice over the coming years may conceivably render my concern 'old fashioned.' The Vice President is in a better position to judge this than I."[44] Neustadt also recommended that the Council be reformed through an internal reorganization plan rather than new legislation.

Neustadt's recommendations, if fully implemented, would have substantially increased the power of the NASC in directing civilian space policy. They reflected a clear rejection of the Eisenhower view of the Council serving primarily as an information conduit to the president. But although reorganization is a popular tool among policy analysts, formal rules are often less important in the formulation of policy than power relationships between the actors—a vice president's personal relationship to a president is more important than any position he holds to advise the president on policy. It was also true by this time that the civilian and military space programs were better deline-

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[42] Richard E. Neustadt, "Memorandum On Organizing the Space Council," February 27, 1961, contained in folder: "NASC Organization - Act, Legislatn, Etc.," *Records of the National Aeronautics and Space Council*, Record Group 220, Box 64, National Archives and Records Administration.

[43] *Ibid.*

[44] Richard E. Neustadt, Consultant, Memorandum for Mr. Bill Moyers, "The Space Council," February 28, 1961, contained in folder: "NASC Organization - Act, Legislatn, Etc.," *Records of the National Aeronautics and Space Council*, Record Group 220, Box 64, National Archives and Records Administration.

ated than they had been in the first years of NASA. The national security space program, including the increasingly important National Reconnaissance Office, was addressed in the NSC, it was *not* to be addressed in the NASC. It is not even clear if Neustadt knew of the existence of the Office of Missile and Satellite Systems at this time.

The only major question in Neustadt's recommendations concerned the constitutionality of appointing the vice president to such a position.[45] However, although there was no legal precedent addressing this issue, there was substantial historical precedent for it.[46] A legislative statute in 1949 made the vice president a member of the National Security Council since it was believed vital that he have access to the knowledge necessary to run the country in the event of a national emergency. It was clear that the vice president was not prevented by the Constitution from serving as the president's delegate, only from exercising authority independent of the Chief Executive.

A March 15, 1961, memorandum from Nicholas Katzenbach, Assistant Attorney General in the Office of Legal Counsel to Vice President Johnson stated that there were no legal or propriety problems with the vice president serving in such a capacity.[47] Katzenbach also suggested that the changes in the Council be accomplished by reorganization rather than legislation, provided that the House approved the extension of the Reorganization Act, which lapsed on June 1, 1959. The Act gave the president wider authority to organize the Executive Office of the President in the way he thought fit. In a second memorandum a month later, Katzenbach stated that there were no constitutional problems as long as the vice president would only be serving in an advisory position, not wielding any power of his own.[48]

But there were operational and turf questions about the arrangement other than legal ones. According to Paul Dembling, who in 1961 was the General Council for NASA, both Kennedy and his newly selected NASA Administrator, James Webb, were concerned about the possibility that Johnson might run the space program. So Kennedy directed that the president control the agenda of the Space Council in order to prevent Johnson from running the American space program from the Office of the Vice Presi-

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[45] "History of The NASC from January 1961-January 1969," pp. 6-9.

[46] "History of the NASC from January 1961-January 1969," pp. 11-12. While FDR was responsible for giving his Vice Presidents something to do, he named new running mates each time he ran for reelection, carefully guarding his own power in the *party* from encroachment by his vice presidents.

[47] Nicholas deB. Katzenbach, Assistant Attorney General, Office of Legal Counsel, Department of Justice, Memorandum for the Vice President, "Reorganization of National Aeronautics and Space Council," March 15, 1961, contained in folder: "NASC Organization - Act, Legislatn, Etc.," *Records of the National Aeronautics and Space Council*, Record Group 220, Box 64, National Archives and Records Administration.

[48] Nicholas deB. Katzenbach, Assistant Attorney General, Office of Legal Counsel, Department of Justice, Memorandum for Vice President, "Constitutionality of the Vice President's service as chairman of the National Aeronautics and Space Council," April 18, 1961, contained in folder: "NASC Organization - Act, Legislatn, Etc.," *Records of the National Aeronautics and Space Council*, Record Group 220, Box 64, National Archives and Records Administration.

dent.[49] Neustadt also outlined a number of issues for the Council to address. These included: the man-in-space program; the use of nuclear power in space; and the implications of the practical applications of space technology, such as communications satellites.[50]

On March 20, 1961, President Kennedy, at the request of Vice President Johnson, nominated Edward C. Welsh to serve as Executive Secretary of the NASC. Welsh had a Ph.D. in Economics from Ohio State University and had served for twelve years in academia. He had also been a member of the National Resources Committee, Temporary National Economic Committee, in the Office of Price Administration, the Department of the Army, and on the National Resources Board and the Reconstruction Finance Corporation. From 1953 to 1961 he served in the office of Senator Symington of Missouri before being nominated by Kennedy to be the first Executive Secretary of the NASC.[51] Welsh testified before the Senate Committee on Aeronautical and Space Sciences on March 23, was confirmed the same day, and took the oath of office the following day. Only four days had passed between his nomination and assuming the post, which was unusually short for the senatorial confirmation process.[52]

The administration apparently decided that waiting for the passage of the extension of the Reorganization Act was less satisfactory than passing new legislation. Welsh immediately set about drafting an amendment to the National Aeronautics and Space Act of 1958 to carry out Kennedy's wishes about restructuring the Space Council. He did not do this single-handedly, but acted in consort with Paul Dembling at NASA and

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[49] "History of The NASC from January 1961-January 1969," p. 2. How exactly this worked is not clear from the records. Presumably, Kennedy was allowed to see and approve the agenda. As it was, the NASC turned out to be far more favorable to NASA's interests than other organizations such as the Bureau of the Budget.

[50] Richard E. Neustadt, "The National Aeronautics and Space Council," March 1, 1961, contained in folder: "NASC Organization - Act, Legislatn, Etc.," *Records of the National Aeronautics and Space Council*, Record Group 220, Box 64, National Archives and Records Administration.

[51] "History of The NASC from January 1961-January 1969," Appendix D: "Staff Appointments, Edward C. Welsh."

[52] *Ibid.*, p. 4. Katzenbach, in his first memorandum, mentioned that the name of the Council would probably be changed to "President's Advisory Council on Space." Neustadt, following a breakfast meeting with the newly appointed Executive Secretary, sent Welsh a memo on the subject. He conceded that the subject was not of vital importance and the fewer changes to the Council the easier it would be to gain Congressional approval. But he did think that a new name was worth considering in order to better establish the Council in Washington and the press. He recommended the name be changed to "President's Space Council" and felt that this was a way to avoid using the acronym "NSC." Welsh had apparently expressed concern that "President's Space Council" might be construed as an attack on the Vice President. Neustadt informed him that the Vice President already chaired the President's Advisory Committee on Equal Employment Opportunity, but he also provided Welsh several other names for consideration, including "National Council on Space," "National Advisory Council on Space" and "Federal Space Council." Ultimately, Welsh decided to keep the original name. See Richard E. Neustadt, Note for Ed Welsh, "Title for the Space Council," April 4, 1961, contained in folder: "NASC Organization - Act, Legislatn, Etc.," *Records of the National Aeronautics and Space Council*, Record Group 220, Box 64, National Archives and Records Administration.

several others. Welsh received the cooperation of many of the vice president's former Senate colleagues in rushing through the legislation in the shortest time possible. On April 12, 1961, Welsh testified on Capitol Hill before the House Committee on Science and Astronautics on the proposed amendment. He explained what changes were being made to the NASC and why. Because Welsh had met extensively with the staff members of the committee and specifically addressed their concerns there were few questions and little opposition to the changes. Also on this date, Yuri Gagarin was launched into space, a fact which was later to play a major role in the NASC's history.

On April 25, 1961, the Aeronautics and Space Act was amended to remove the president from the Council and replace him with the vice president. The Council was also fixed within the Executive Office of the President, placing it in the same position in the bureaucracy as the National Security Council and the Bureau of the Budget and removing any ambiguity about where it lay in the Executive Branch. Additionally, the appointed members of the Council were eliminated and the scope of its work was expanded to include overview of not only NASA and DOD, but of all agencies and departments of the United States engaged in aeronautics and space activities—except the Office of Missile and Satellite Systems.[53] Because the scope of space operations had increased dramatically since the creation of the Council, and because meetings might be called at a moment's notice, it no longer made sense to have outside experts serve as advisors. The requisite experience could be found within the government and outside consultants could be brought in on an ad hoc basis. Although space activities had still remained confined to NASA and DOD, it was possible that they might soon spread to other areas of the government and the Council's enabling language was changed to reflect this.

Welsh immediately set about selecting a staff. He wanted this to be small and to rely heavily on the staffs of the agencies which belonged to the Council—primarily NASA and the DOD. While doing this, Welsh also drew up a budget for the Council. The Fiscal Year 1962 budget requested and ultimately appropriated was $545,000. The budget decreased slightly in the next few years, but never dropped below $500,000 during the entire time Welsh served as secretary.[54]

Welsh concentrated on recruiting scientists and technicians who specialized in the issues most likely to come before the Council, including communications, meteorology, navigation, military space, space science, boosters and propulsion, atomic energy, international relations and legislative and budgetary matters.[55] These staff members were given the title of "aerospace assistants" and reported directly to Welsh. They were expected to keep abreast of policy issues and technological developments in their respec-

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[53] See, *Staff Report Prepared for the Committee on Aeronautical and Space Sciences*, United States Senate, "National Aeronautics and Space Act of 1958 As Amended Through October 6, 1961," October 6, 1961, p. 3, footnote 1.

[54] "History of The NASC from January 1961-January 1969," pp. 17, 19.

[55] *Preliminary Inventory of the Records of the National Aeronautics and Space Council*, Record Group 220, Compiled by Jarritus Wolfinger, National Archives and Records Service, Washington, 1977, Introduction, p. 2.

tive areas and to inform Welsh of these, as well as to assist in the preparation of messages and speeches on space matters for the President. Although the NASC primarily addressed civilian space issues, it was necessary for the aerospace assistants to have top secret compartmented clearances such as TALENT-KEYHOLE, Q Clearance and others.[56]

The NASC and the Lunar Decision

Before the newly revised Council was in existence other events were to take place in which the NASC would play a crucial role. Upon Kennedy's assuming office he had already announced his intention to place Johnson in a key position in the formulation of national space policy. Because of Johnson's past experience in space matters and his close ties to Capitol Hill, it would have been difficult for Kennedy to ignore the Vice President on space issues had he been so inclined. But although Kennedy had been elected in part upon his campaign rhetoric of a "missile gap," he assumed office with little concern about space policy. In January of 1961 Kennedy became annoyed at the failure of aides to agree on criteria for selecting a new NASA administrator and pushed the selection process forward. While Kennedy brought in younger people in many other areas of the government, Johnson was allowed to influence the selection process and name a man with a great deal of political experience, James Webb, who was sworn in on February 14.[57]

After conducting a review of NASA's programs, Webb submitted a request to the Bureau of the Budget for an addition of $308 million on March 17. The BoB director, David Bell, was unwilling to give NASA more than an additional $50 million and, as a result, Webb asked Bell to request a meeting with the president to discuss the issue.[58] On March 22, 1961, only two days after Welsh's nomination to the position of executive secretary, Welsh, Webb, Bell and several other officials from NASA and BoB briefed Johnson and then met with Kennedy to discuss the supplemental appropriation for NASA. The two items on the agenda were the need for the United States to quickly close the gap on the Soviet Union's payload-lifting capability and the advance of manned spaceflight beyond Project Mercury. Welsh's briefing memorandum to Johnson had stated that the United States needed to decide whether or not it was important to close the gap in space capability and, if so, to accelerate the space vehicle and rocket

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[56] E.C. Welsh, Memorandum for Mr. Bromley Smith, May 19, 1967, *Records of the National Aeronautics and Space Council*, Record Group 220, Box 30, National Archives and Records Administration. TALENT-KEYHOLE refers to access to satellite photo-reconnaissance pictures. Q Clearance is a top level Atomic Energy Commission clearance.

[57] Logsdon, *Decision to Go to the Moon*, pp. 83-85. Rather surprisingly, Webb apparently solicited a promise from Kennedy that he would be given free reign over the space agency and would not face interference from the man who had selected him—Johnson.

[58] *Ibid.*, p. 91.

engine programs. The next day Kennedy met with Johnson, Welsh and Bell during which Johnson deferred to Welsh who argued strongly in favor of NASA's request.[59]

The result of the meeting was that Kennedy approved a budget increase of $126 million, most of which was to go to advanced propulsion. Kennedy did not approve any money for Project Apollo, although some of the money was allocated to the Saturn rocket program. Kennedy had decided to place greater emphasis on space, but not to make it a priority or to approve human spaceflight programs beyond Project Mercury. Events were soon to force another decision.

On April 12, 1961, the same day that Welsh testified on Capitol Hill about proposed changes to the Space Council, the Soviet Union launched Yuri Gagarin into orbit aboard a Vostok spacecraft. On April 14, in a Friday evening discussion at the White House, Kennedy conferred with Johnson, Welsh, Bell, Webb, NASA Deputy Administrator Hugh Dryden, Presidential Science Advisor Jerome Wiesner and presidential aide Ted Sorenson. Kennedy asked what the nation could do to catch up with the Soviets, questioning which missions were feasible and what was the status of the various programs, such as Saturn, which were then in development.[60] On April 19, Johnson met with Kennedy again, alone, and the President asked Johnson for his recommendations for an accelerated space program. Johnson suggested that he be authorized to hold meetings on the issue and prepare a platform to be submitted to Congress. He asked Kennedy to provide him with a memorandum asking for the Space Council to address the issue. The next day Kennedy provided it and it stands as an important document in the development of the structure of American space policy-making. The most important part of the document was Kennedy's opening question:

> In accordance with our conversation I would like for you as Chairman of the Space Council to be in charge of making an overall survey of where we stand in space.
>
> 1. Do we have a chance of beating the Soviets by putting a laboratory in space, or by a trip around the moon, or by a rocket to land on the moon, or by a rocket to go to the moon and back with a man. Is there any other space program which promises dramatic results in which we could win?[61]

Kennedy had earlier asked Johnson to study the manned space program to aid him in a consideration of Project Apollo.[62] He was now dramatically increasing the scope of that survey and giving the National Aeronautics and Space Council its first major task in the new administration, five days before Johnson was officially named chairman of the

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[59] *Ibid.*, pp. 95-97. See also, "History of The NASC from January 1961-January 1969," pp. 21-22.

[60] Logsdon, *Decision to Go to the Moon*, p. 106.

[61] John F. Kennedy to Lyndon B. Johnson, April 20, 1961, NASA Historical Reference Collection. This document is in both the Kennedy and Johnson presidential libraries and is also reprinted in the NASA History Office monograph by Roger D. Launius, *Apollo: A Retrospective Analysis* (Washington, DC: Monographs in Aerospace History, Number 3, July 1994).

[62] Logsdon, *Decision to Go to the Moon*, p. 110.

revised Council. Johnson did not have a fully functioning NASC at his disposal since Welsh was the only staff member at the time. But Johnson pursued the assigned task in the way he conducted much of his business—through direct meetings with those involved. On April 22, he met with NASA officials who told him that there was no chance of the United States beating the Soviets at orbiting a manned orbiting laboratory, but that it was possible for the U.S. to beat the Soviets to a manned circumnavigation of the Moon with a possible lunar landing by 1967. Johnson also met separately with representatives from the Department of Defense, the Atomic Energy Commission, and the Office of the President's Science Advisor. A BoB representative sat in on the meeting, as well as Wernher von Braun, Director of Marshall Space Flight Center; General Bernard Schriever, Commander of the Air Force Systems Command; and Vice Admiral John T. Hayward, Deputy Chief of Naval Operations for research and development. Johnson had directly solicited their views, bypassing normal channels due to his own personal style and the urgency of the subject.[63] All three of these men intended to provide the views of the individual military services, recommended the establishment of the lunar landing goal.[64] Johnson had pressed NASA to be both specific and ambitious, and although he did not directly state what project he wanted the agency to support, it was obvious to Webb that Johnson was advocating the lunar goal.

On April 28, Johnson sent a five and a half page memorandum to Kennedy which answered the questions outlined in the April 20 memorandum from Kennedy. Because of its importance as one of the seminal documents of the American civil space program as well as being the first significant document to emerge from the new NASC, portions of the memorandum are excerpted below. The memorandum stated in part:

> The following general conclusions can be reported:
>
> a. Largely due to their concentrated efforts and their earlier emphasis upon the development of large rocket engines, the Soviets are ahead of the United States in world prestige attained through impressive technological accomplishments in space.
>
> b. The U.S. has greater resources than the U.S.S.R. for attaining space leadership but has failed to make the necessary hard decisions and to marshal those resources to achieve such leadership.
>
> c. This country should be realistic and recognize that other nations, regardless of their appreciation of our idealistic values, will tend to align themselves with the country which they believe will be the world leader—the winner in the long run. Dramatic accomplishments in space are being increasingly identified as a major indicator of world leadership.

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[63] *Ibid.*, p. 114.

[64] Von Braun had been included as former director of the Army's rocket program at the Army Ballistic Missile Agency, which had been incorporated into NASA, not as a representative from NASA. Von Braun submitted his recommendations on his personal stationery. See Logsdon, *Decision to Go to the Moon*, p. 114, footnote 83.

> g. Manned exploration of the moon, for example, is not only an achievement with great propaganda value, but it is essential as an objective whether or not we are first in its accomplishment—and we may be able to be first. We cannot leapfrog such accomplishments, as they are essential sources of knowledge and experience for even greater successes in space. We cannot expect the Russians to transfer the benefits of their experiences or the advantages of their capabilities to us. We must do these things ourselves.[65]

The memorandum went on to restate the questions in Kennedy's April 20 memorandum and to answer them. The most important part of the memorandum stated, "The Russians have had more experience with large boosters and with flights of dogs and man. Hence they might be conceded a time advantage in circumnavigation of the moon and also in a manned trip to the moon. However, with a strong effort, the United States could conceivably be first in those two accomplishments by 1966 or 1967." Finally, the memorandum recommended the acceleration of all areas of booster development and concluded by stating, "We are neither making maximum effort nor achieving results necessary if this country is to reach a position of leadership."[66]

The memorandum never expressed directly that the United States should establish the lunar goal. But it claimed that leadership in space was important and that if Kennedy felt the United States should be a leader, then the lunar goal offered the clearest chance for success in beating the Soviets. In serving in his role as advisor to the president on space issues, Johnson had listed the options available to him in such a way that it would be difficult for Kennedy to avoid coming to the lunar decision even if he had not already been leaning towards it. The memorandum also clearly established that Apollo had its origins in the Cold War struggle between the superpowers. The value of the propaganda effects of leadership in space was clearly stated as a reason for making this a priority.

Johnson held another meeting on May 3 and met with President Kennedy on May 10. On May 25, 1961, in an address to a joint session of Congress, Kennedy announced the goal, "before this decade is out, of landing a man on the Moon and returning him safely to the Earth."

The early actions of the National Aeronautics and Space Council were driven entirely by Johnson, with the assistance of Welsh. Without a staff or a framework of how to conduct business, Johnson met with the various representatives serving on the Council and issued a report to the President in little over a week.[67] It is also important to note that in this instance the impetus for NASC action came from President Kennedy. The president's willingness to listen and to act determined the power of the body. He requested policy advice from the NASC and was already inclined to accept the proposal that was presented to him.

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[65] Lyndon B. Johnson, Memorandum for the President, "Evaluation of Space Program," April 28, 1961, pp. 1-3, NASA Historical Reference Collection. It is also reprinted in Launius, *Apollo: A Retrospective Analysis*.

[66] *Ibid.*, p. 6.

[67] Logsdon, *Decision to Go to the Moon*, p. 118, footnote 93.

Revising National Space Policy

There is no set model for how public policy is made in the Executive Branch. The common view is that the decision-maker, in the case of the Apollo commitment it was Kennedy, identifies a problem and then sets his staff to find a solution and make recommendations to him. This is clearly what happened in the case of the decision to establish the lunar landing goal. But quite frequently the chain of events is much more complicated. One of the primary reasons that presidents have advisory bodies such as the NASC is to bring issues to their attention so that the Chief Executive can then issue a directive that they be further explored. This is a more complex process than simply telling the president about a problem and recommending solutions that he can then choose from. It involves a great deal of political maneuvering and competing for attention at all levels. It is also an iterative process whereby the policy advisors help to clarify the decision-makers' priorities and both move toward a better understanding of the problem. The point is that in many ways the lunar decision-making process was unusual, or at least different from the norm. Kennedy was very concerned about the issue and wanted action. It was then up to the NASC to recommend what should be done.

Indeed, a better idea of how the policy-making process normally worked in the space council can be seen from looking at the creation of a national space policy. On May 9, 1962, a year after Kennedy had announced the lunar goal, Welsh informed his staff that he felt it necessary that the Space Council "draft a comprehensive statement of national space policy." Five days later, on May 14, 1961, Bromley Smith, the Executive Secretary of the National Security Council, notified Welsh that "all outstanding NSC policy papers inherited from the previous Administration be examined for recision, review or reconstruction."[68] Welsh probably knew that this order was coming. The last declaration of national space policy had been approved by President Eisenhower on January 26, 1960, and not only did it reflect a previous president's priorities in space, it had also been surpassed by subsequent events such as Gagarin's launch and Kennedy's lunar decision. The previous national space policy had also been drafted in the National Security Council, not the Space Council. In Welsh's view, a new policy document on the issue was needed.

The purpose of such documents must be neither overstated nor understated. Frequently, senior officials are not aware of the existence of high-level policy documents intended to guide their actions and they occasionally pursue policies that contradict them. But such documents are intended to set the overall tone of the administration's views on certain issues and to establish a framework to guide action at all levels. They are more important as they are being created and finalized than after they have been issued, since they force the participants to clarify and negotiate positions on important issues. They are generally successful if administration policy on the issue is fairly homogeneous and if relations between senior advisors and officials are good. But it can be particularly troublesome if the documents are intended to establish lines of authority and responsibility, or if the lines of communication between agencies are poor.

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[68] "History of The NASC from January 1961-January 1969," p. 35.

A national space policy document was already being worked on by the staff when Bromley Smith issued his pronouncement. It was accelerated and Welsh called a meeting of member agencies on May 17 to review a draft of this document. This meeting was to be composed of staff only, the principals, including the vice president, would be advised of progress and would formally review the document when it neared its final form. Interagency meetings were held on May 16, 24, and 31, and June 9 with language changes submitted in writing.[69]

Welsh's plans were placed in jeopardy on June 14 when McGeorge Bundy, Special Assistant to the President for National Security Affairs questioned whether or not the statement should be unclassified. Although Bundy did not sit on the NASC, as head of the National Security Council he still had a right to comment on matters that he felt had an impact on national security and he had the ear of the president if that became necessary. It was the first time that the NSC and the space community disagreed over an issue of policy and it was certainly not going to be the last.

Welsh, in a memorandum to Bundy the same day, not only argued in favor of a declassified statement of space policy, but defended the need for such a document in the first place. Welsh argued that a declassified national space policy was necessary out of a need for clear policy direction and openness.[70]

Welsh then met with Bundy to further explain his position. Bundy's concern was that such a statement would unduly draw attention to the military space program. Welsh argued that it made no sense to conceal the fact that the United States was spending $1.5 billion on military space or to withhold from the American public information on U.S. policy and performance that the Soviets already knew. Bundy agreed to reconsider his position and Welsh removed some references to the national security aspects of the space policy from the draft document.

During a July 12, 1962 meeting of the NASC called to brief the principles on progress in astronaut training and the selection of a lunar landing method, Vice President Johnson commented that he hoped that differences of opinion over the policy document could be resolved. Later that month, on July 31, Welsh noted in a letter to Webb that he appreciated the NASA Administrator's help on the document.

But on August 17, Webb sent a letter to Welsh that stated, "Confirming our recent telephone conversation, I do not favor the issuance of an unclassified policy statement on outer space at this time."[71] This presented a problem for Welsh, for, as he understood the conversation, Webb did not *support* the issuance of such a statement, but would not object to it if any other member of the Council thought it was necessary. Welsh had relayed his interpretation of Webb's position to Johnson during a report on the status of the statement. He had also reported that Chairman of the Atomic Energy Commission Glenn T. Seaborg had clearly indicated he thought such a statement of policy necessary. Furthermore, Under Secretary of State McGee had also argued on behalf of an "authori-

[69] *Ibid.*, p. 36.

[70] *Ibid.*, pp. 37-38.

[71] *Ibid.*, p. 39.

tative public statement" to follow a classified policy statement. Welsh was confused by Webb's position since he interpreted the assistance of various NASA staffers in drafting the statement as an indication of support for it. He did not want to see the work done to date abandoned completely and asked for Webb's help in revising the document so that it would be more acceptable to him. Welsh's letter hinted at confusion as to why the *civilian* NASA Administrator wanted official American space policy kept secret. In Welsh's view, the public had a right to know. But Webb apparently opposed the document out of a belief that it would disrupt the internal budgeting process and lead to conflict with Capitol Hill. Keeping policy out of sight enabled the policy makers to keep internal conflicts out of sight as well. Although it had not voiced objections to the document, the Defense Department also had reservations about a public statement of policy. As a result, the NASC did not formally endorse the document, although both Welsh and Johnson used its contents in various public statements, articles and speeches.

The State Department produced a classified statement of space policy by November 19, 1962. Apparently only intended for State Department use, this document provided guidance on such subjects as: essential elements of an overall national program; scope of the national space effort; priorities of the several programs comprising the national effort; a regime of law for outer space; arms control and disarmament measures; international cooperation; openness in the conduct of U.S. space activities; the public image of the U.S. space program; and intelligence requirements concerning the public release of information on Soviet space events and failures.[72]

Having lost the first round under rather embarrassing circumstances and seeing some of his authority usurped with the formulation of a State Department statement of space policy, Welsh waited several months before trying again. In a letter to the Council dated February 18, 1963, Welsh indicated that he felt it time to begin drafting a classified coordinated policy statement. He had apparently abandoned his earlier insistence on a declassified document since neither NASA nor the DoD was likely to support it and the State Department would endorse only a public statement, not a completely unclassified document. This time, although NASA made some contributions to the draft document, the Defense Department refused to cooperate and once again the attempt to formulate a national space policy document failed. A formal statement of American space policy, either classified or unclassified, never emerged from the National Aeronautics and Space Council during its entire existence despite the efforts of its executive secretary. It was not an issue in which Johnson expressed a great deal of interest.

The NASC's Role in the Formation of Comsat

Another issue in which Welsh and the Council played an important role was the development of Comsat and the United States' telecommunications policy. Early U.S. policy on satellite communications technology and related issues was haphazard. Eisenhower had seen little need for government involvement in the communications satellite

[72] *Ibid.*, p. 41.

issue and felt that private initiatives were best. Shortly before he left office, he issued a number of policy statements in order to set the agenda on various issues, including communications satellite policy. In a statement released to the press on December 30, 1960, Eisenhower reiterated his position that private industry should establish and operate communications satellite systems.

But while Eisenhower had a position on the issue, the rest of the government apparently did not. NASA and the DoD had both been assigned responsibility for technology development, but the Federal Communications Commission had a say in the allocation of frequencies. In addition, several other committees and organizations, both within the U.S. government and internationally, were responsible for different aspects of the subject. Private industry wanted clearer, better-defined government policy and regulation concerning satellite communications. But there was a bigger problem. In 1960 it was believed that any satellite communications system would involve medium-altitude satellites in a constellation, making development of such a system extremely expensive. The only company with the resources to develop such a system was AT&T and many legislators and members of both the Eisenhower and Kennedy administrations feared an AT&T monopoly.

Fred Kappel, president of AT&T, had been petitioning the government since 1960 for permission to field a satellite-based communications system and had been virtually ignored by NASA.[73] In memoranda in May 1961, Welsh recommended to the Director of the Bureau of the Budget that more funds be allocated to satellite communications research.[74] Kennedy responded in his May 25 address to Congress by requesting a $50 million increase for this area. A few days later, State Department officials advised the Council staff of their concerns on the international implications of current, essentially de facto, policy. Welsh was unhappy with the response he received from NASA Administrator Webb on the issue of communications satellites and urged the vice president to call a Council meeting to address some of the policy issues related to them. Of particular concern to Welsh was Webb's claim that he was responsible for coordinating policy on the issue.

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[73] See, for instance, F.R. Kappel, President, American Telephone and Telegraph Company, to the Honorable James E. Webb, Administrator, NASA, April 5, 1961, with attachments: G.L. Best, Vice President, to Dr. T. Keith Glennan, Administrator, NASA, September 15, 1960; E.I. Green, Executive Vice President, to Dr. T. Keith Glennan, Administrator, NASA, October 20, 1960, *Proposed Bell System Experiment on Active Satellite Communication*; T. Keith Glennan, Administrator, to Mr. G.L. Best, Vice President, American Telephone and Telegraph Company, September 28, 1960; F.R. Kappel, to Dr. T. Keith Glennan, Administrator, NASA, December 14, 1960; C.R. Smith, Defense Activities Division, Western Electric Company, to Procurement and Supply Division, Goddard Space Flight Center, NASA, March 20, 1961; and J.E. Dingman, to Mr. Ben F. Waple, Acting Secretary, Federal Communications Commission, March 21, 1961, contained in "F.R. Kappel Folder, Autobiographical Files," NASA Historical Reference Collection. Kappel's April 5 letter to Webb expressed his concern with some of Webb's recent statements on satellite communications policy and indicated his desire to meet with Webb to address the issue. He outlined his company's past correspondence with Webb's predecessor, Glennan, and stated that he wished to meet with Webb at the earliest possible time.

[74] "History of The NASC from January 1961-January 1969," p. 65.

In further staff meetings it became clear that the State Department wanted clear guidance on U.S. policy on this issue since they felt the current position was too abstract and feared the possible announcement of a joint French, British, and West German communications satellite program.[75] Representatives of the State Department were also further concerned that the FCC have adequate guidelines for approving private company requests for developing systems. Basing the American communications satellite program on economic considerations alone could damage the foreign policy position of the United States in future deliberations abroad, according to these officials. Other members of the government were worried that satellite communications could become a monopoly dominated by AT&T. Because of this, the Council recommended that NASA fund communications satellite R&D and provide the results of this research to private enterprise. President Kennedy was also anxious that an international satellite communications system be established as early as possible, providing for private ownership and operation of the U.S. part of the system. He also wanted to provide technical assistance for developing countries which wanted to participate in the system.

The Council staff met several times in late June and early July of 1961 to address the issue and a draft statement was written and discussed in a meeting of the full Council on July 14. After those present meticulously went over the draft statement, it was approved unanimously and transmitted to the president where it was released as a public document on July 24.[76] Although it was not broad reaching, it did establish that ownership of any communications satellite system would be private and subject to regulation by the government. This policy led to a protest letter signed by thirty-five members of Congress, led by Emanuel Celler, Chairman of the House Committee on the Judiciary. The letter expressed the opinion that the question of ownership should not be settled until after a system had been developed and become fully operational—entirely at government expense.[77]

Before the statement on communications satellite policy was completed, the Council staff turned its attention to the issue of patent aspects of communications satellite technology. The government's position on this area was finalized and outlined in a letter to Senator McClellan, who was Chairman of the Senate Subcommittee on Patents, Trademarks, and Copyrights, on November 16, 1961.[78]

Welsh had been considering the question of ownership of communications satellites for much of this time. The July 24 policy paper had stated that the NASC would continue to have a role in the field. In the fall of 1961, Kennedy, in a rather unusual move, directly requested that Welsh and his staff come up with recommendations on how to implement the policy. A meeting in early November addressed the issue of

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[75] *Ibid.*, p. 70.

[76] White House Press Release, July 24, 1961.

[77] Emanuel Celler, Chairman, Committee on the Judiciary, House of Representatives, Congress of the United States, et al., to the President, August 24, 1961, contained in "Comsat Files," NASA Historical Reference Collection.

[78] "History of The NASC from January 1961-January 1969," p. 77.

whether or not legislation or a policy statement was needed for this subject and on November 9, Kennedy requested that Welsh have a draft recommendation for communications satellite policy ready by the first of December.

On November 13, 1961, the FCC Ad Hoc Carrier Committee Report proposed that a non-profit corporation be established to develop and operate the communications satellite program. This corporation would lease circuits to authorized carriers, which would own the satellites as well as their ground stations. The corporation would be run by a board of directors including representatives of AT&T, ITT, RCA and Western Union and three public directors appointed by the President. The committee's report resulted in immediate controversy. The other three carriers expressed concern that the corporation would be dominated by AT&T, while representatives of other aerospace and electronics manufacturers were unhappy that they would be excluded from participation in such a revolutionary field.[79] The FCC had replied that their participation was neither "necessary nor beneficial."[80]

The NASC held interagency meetings on November 14, 15, 17, 22, and 24 to discuss the issue and incorporated much of the FCC committee's report into its legislation. On the 27th Welsh presented the vice president a draft bill which provided for Congressional authorization of a privately owned profitable corporation which was open to virtually all interested parties. The corporation would own satellites and ground stations, and the president would "provide for surveillance and coordination of the development and operation of the system, so as to make certain that the public interest aspects were met and that the operational date was achieved as soon as possible."[81]

This draft bill was then circulated to various government agencies such as the FCC, the Department of Defense, the State Department and NASA for their comments. Although neither NASA nor the FCC had major problems with the draft, both voiced concerns over the openness of the plan. NASA felt that membership in the corporation should be limited to "common carriers," in other words, only current international communications companies. The FCC had already taken a similar position.[82]

Johnson transmitted the draft bill to Kennedy on December 1, 1961, and noted both the FCC and NASA's objections as well as the fact that the document had not been formally voted on in the Council. Since it was only a *proposal* for legislation, not an actual policy document itself, Johnson had not felt the need for involvement of the full Council.

While all of this was taking place in the NASC, Senator Robert Kerr had announced and released a draft bill that would have amended the National Aeronautics and

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[79] Frederick G. Dutton, Memorandum for the President, November 13, 1961, contained in: "White House Files," NASA Historical Reference Collection.

[80] Ben F. Waple, Acting Secretary, Federal Communications Commission, "An Inquiry Into the Administrative and Regulatory Problems Relating to the Authorization of Commercially Operable Space Communications Systems: First Report," FCC Report 61-676, 4774, Docket No. 14024, May 24, 1961, contained in "FCC Files," NASA Historical Reference Collection.

[81] *Ibid.*, p. 80.

[82] *Ibid.*, p. 81.

Space Act in order to organize a communications satellite system. Kerr's bill would have made space communications entirely private. Senator Estes Kefauver also introduced a bill that would have made communications satellites entirely a governmental enterprise on the grounds that the technology and launch equipment had been developed at taxpayer expense.

Kennedy soon requested that Welsh compare the NASC's proposal with Kerr's draft bill. Kennedy made some changes to the NASC proposal, primarily limiting participation to "common carriers," and sent the proposed bill to Congress on February 7, 1962. A month later, Welsh testified before the Senate Committee on Aeronautical and Space Sciences and then before the House Committee on Interstate and Foreign Commerce. On April 10, 1962, he testified before the Senate Interstate and Foreign Commerce Committee. Although Welsh later said that he felt it was clear that the President's legislation was going to pass, it did run into opposition in the Senate, where liberal Democrats, led by Kefauver, opposed the bill and filibustered it. Ultimately, the Senate invoked cloture against the bill, something that was quite rare at that time.

The bill passed the House on May 3, 1962 by a vote of 354 to 9 and the Senate on August 11 by a vote of 66 to 11. It was amended slightly to reflect the Senate's version and passed the House again on August 27, 1962. The legislation called for the creation of a new public-private corporation known as Comsat, with ownership divided equally between the general public and the four telecommunications corporations—AT&T, ITT, RCA, and Western Union International. Comsat's Board of Directors was made up of six representatives of the public stockholders, six representatives of the telecommunications industry, and three presidential appointees. The corporation was designated as the official representative of the United States for global satellite communications and two years later became the manager of the global system formed on August 20, 1964 and known as the International Telecommunications Satellite Consortium (INTELSAT).

Comsat, as ultimately incorporated, owed a great deal of its existence to Welsh's efforts. He led the creation of the draft legislation as a staff effort largely without the input of the official members of the Council, including the vice president. He did this at Kennedy's request. The legislation largely reflected Welsh's belief that although the corporation should be privately owned and operated, there was a substantial public interest in the venture. Welsh stated that he had no opposition to government ownership if he felt that was the only way to protect the public's interest. Comsat, perhaps more than any other single policy or piece of legislation, reflects Welsh's influence and efforts on the Council and how such an organization can be successful if given high level support.

The NASC and Bureau of the Budget Differ Over the Space Program

Another issue which highlighted the effect of the NASC on policy-making concerned NASA's budget. In the second half of 1962, Kennedy requested that NASA, the Department of Defense and the Bureau of the Budget conduct an "especially critical review" of the total national space effort (excluding the intelligence space program headed by the NRO). Several factors had led to Kennedy's call for a review: NASA's decision to adopt the lunar orbital rendezvous approach to the lunar landing; the space agency's upward revision of budget estimates for Apollo; a suggestion by Brainard Holmes, the person in charge of the Apollo program, that the target date for the first landing attempt be moved up from late 1967 to late 1966; and the lack of evidence that the Soviet Union was itself carrying out a lunar landing program.[83] The Director of the Bureau of the Budget, David E. Bell, issued a memorandum to the President on November 13, 1962, which was critical of NASA's argument that it should lead in all areas of space exploration.[84] This was not a NASC report and did not involve any of the staff of the NASC or Vice President Johnson.

On April 9, 1963, Kennedy again asked for a careful review of the nation's civil space program. But this time he issued the request to the vice president and the NASC, rather than to the Bureau of the Budget. Kennedy wanted to know the differences between the NASA program as projected on January 1, 1961 for the years 1962 through 1970 (i.e. Eisenhower's space program) and the NASA program as defined by his administration. He also wanted to know the benefits to the economy from the expanded program, the major problems that might result in the economy due to the diversion of resources to the space program, the extent to which the Apollo program could be reduced, and the degree of coordination between the Department of Defense and NASA on the development of boosters.[85]

The NASC's reply was transmitted to Kennedy by the vice president the following month. The report noted that the program accelerations that President Kennedy had announced in his May 1961 speech would require a budget over $30 billion greater during the 1960s than had been anticipated at the end of the Eisenhower administration. It attributed this to four factors: the lunar project; the greater breadth of scientific endeavor; the expansion of space applications; and the sense of urgency. The report also noted that the program would have positive effects on the economy as it pumped money into high technology areas.[86] According to the NASC, the benefits of a vigorous space program for the nation were substantial. This report differed substantially in tone from the BoB memorandum.

The NASC Fades In Importance

After Kennedy's assassination in November 1963, Johnson assumed the presidency and appointed Edward Welsh as interim head of the NASC until Hubert Humphrey

[83] On this latter point, it has been only recently revealed that the Soviets did not formally approve their lunar landing program until 1964.

[84] Director, Bureau of the Budget, Memorandum for the President, Draft, November 13, 1962, with attached: "Space Activities of the U.S. Government," contained in "White House Files," NASA Historical Reference Collection. Apparently, this draft document was submitted to President Kennedy.

[85] John F. Kennedy, Memorandum for the Vice President, April 9, 1963, contained in "White House Files," NASA Historical Reference Collection.

[86] Lyndon B. Johnson, Vice President, to the President, May 13, 1963, with attached report, contained in "White House Files," NASA Historical Reference Collection.

became vice president in 1965. The law permitted Johnson to appoint one of the statutory members to act as chairman for each meeting.[87] While this reflected Johnson's faith in Welsh, it also was the beginning of the end of the extensive influence that the Council briefly exerted on space policy during the Kennedy administration. Although Johnson was fully committed to carrying out Kennedy's lunar goal, he never again showed the interest in space issues that he had during previous years. Once he became president, Johnson had other issues which concerned him far more than the space program and as a result, the NASC lost influence. By this time, Johnson also viewed space reconnaissance as the most important aspect of the space program and space reconnaissance was not an issue addressed by the Space Council.[88]

The NASC met formally thirty times between July 14, 1961, and May 22, 1968.[89] The Council addressed such issues as international cooperation, nuclear propulsion and power, the supersonic transport, information policy and the Manned Orbiting Laboratory. It also continued to address issues raised when Johnson was chairman, such as the need for a national space policy and the revising of telecommunications policy. It almost never addressed exclusively military space issues. The Council also prepared the annual report *United States Aeronautics and Space Activities*. After the initial success in contributing to the lunar decision, the Council played only a limited role in formulating space policy, with the exception of the creation of Comsat. Eisenhower's argument that the DoD and NASA should play the major role in determining their own objectives was the practice during the remainder of the Council's existence.

Space issues after the lunar decision never received sufficient presidential attention to solidify the Council's role as a policy formation agency. Instead, it became a source for presidential information on space operations, rather than a policy advisory board.

By the time Richard Nixon was elected in November 1968, the Council was widely regarded by many in the space community as an unimportant player, confined mainly to providing information to the President and the public concerning programs which it played little role in developing. Why the Council faded so quickly in importance after Kennedy's death has to do with a number of factors. Foremost of these was the departure of Johnson as Chairman.

Lyndon Johnson was perhaps the shrewdest politician that the country has produced. He embraced the space issue early as a means of attacking a Republican president. Indeed, it is difficult to determine whether Johnson was truly interested in space exploration or merely insightful and opportunistic enough to recognize its value in furthering his own political agenda. Once he lost the Democratic nomination to Kennedy and accepted the number two spot on the Democratic ticket, Johnson needed a means both of exercising his dynamism and keeping himself in the public eye. The Chairmanship of the NASC accomplished both and Johnson was clearly its most active and influential leader. He used it as a vehicle to advance his own ambitions until it no longer

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[87] "History of The NASC from January 1961-January 1969," p. 16.

[88] Richelson, *Secret Eyes in Space*, p. 93.

[89] "History of The NASC from January 1961-January 1969," Appendix A, "NASC Meetings (1961-1968)."

became necessary. Once president, Johnson had other issues to address and space fell by the wayside. Despite the best efforts of his capable staffer Welsh, the NASC lost influence as the president no longer paid much attention to its activities.

Figure 2 Vice President Hubert H. Humphrey (right) visited the Kennedy Space Center, Florida, on March 23, 1965 for the launching of NASA's Gemini III mission. Shown with the vice president are (left to right) Dr. Edward C. Welsh, Council Executive Secretary, and Dr. Robert C. Seaman's Jr., NASA Associate Administrator. Photograph from NASA collections, no. 65 H 455.

Furthermore, by the mid-1960s, the Apollo Program was in full swing. NASA was too preoccupied with an existing program to devote much attention to future programs. James Webb, recognizing the intrinsic link between political support and the space program, opposed any plan to set long-range goals for the space agency beyond Apollo.[90]

[90] Webb ultimately may have come to realize that this was a mistake, for by 1967 he had lost much of his influence within the agency he ran and struggled to regain it.

An activist policy-making body naturally assumed less importance as its early policies were implemented.

Welsh confined his last days as Executive Secretary to closing out issues with which the Council was involved, preparing a report for his as yet unknown successor, and writing an internal history of the Council's activities.[91] Welsh's resignation was accepted by President Nixon on February 4, 1969.

The NASC under Richard Nixon

When Richard Nixon entered the White House in January 1969, space was very low on his list of priorities. The Vietnam War, other foreign policy issues and a desire to reign in a swelling bureaucracy were the primary concerns of his administration. Nixon appointed a number of transition teams to advise the new government, including a Task Force on Space chaired by Charles Townes, a Nobel Prize winner of the University of California at Berkeley.

The Task Force addressed a number of issues confronting the space program such as funding levels for NASA, goals and missions, and the future of the NASC. The report was blunt: "The Space Council has not been very effective."[92] Further, it went on to say, "Although the new President will have the option of asking Congress to abolish the Council, or of not calling any meetings, we believe that as long as the Council exists and is used it should be made effective. For that purpose, there should be a strong staff and the President should be the Chairman. The latter will require new legislation."[93] Rather ironically, this conclusion and recommendation was virtually identical to one that Kennedy had received in 1960, calling for a reinvigoration of the Council. But unlike Kennedy, Nixon did not take this advice. Instead, the Council was relegated to a virtual bureaucratic limbo for the next three and a half years.

It was clear to most of those involved that the biggest issues facing the civilian space program were the goals and funding levels for NASA in the post-Apollo era. This had been clearly stated in the Task Force report, which had recommended that a study be undertaken to address future goals for NASA. Lee DuBridge, the President's new Science Adviser, wanted to carry out the review of goals and missions under his authority. DuBridge, as President of the California Institute of Technology, the home of JPL, had clashed with NASA Administrator James Webb during the 60s, both over robotic versus human exploration (DuBridge favored the former) and personally. Indeed, Webb had found DuBridge unresponsive to his attempts to reform JPL and, after the failure of Ranger 6, in January 1964, had gone over DuBridge's head to Arnold O. Beckman,

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[91] This history, reflecting the influence of the Council, contains considerably more detail on the Council's early activities than its later ones.

[92] Report of the Task Force on Space, January 8, 1969, p. 7 contained in "White House Files," NASA Historical Reference Collection.

[93] *Ibid.*, p. 27.

Chairman of the Caltech Board of Trustees, to successfully resolve the situation.[94] The two men did not like each other.

With Webb gone, a new administration in power, and himself in a position of authority, DuBridge felt that he could exert greater emphasis on the future of the space program and wanted to head the study. But NASA indicated to the White House its opposition to DuBridge. Since the Space Council had fallen into disuse and lacked a staff, it was not a good choice to conduct the study. Nine days after accepting Welsh's resignation, Nixon announced a compromise, appointing Vice President Spiro Agnew, who was by law Chairman of the NASC, to chair the study, and assigning administrative support to DuBridge and his staff in the Office of Science and Technology. In addition to Agnew, the Space Task Group, as it became known, consisted of Secretary of the Air Force Robert C. Seamans, Thomas O. Paine, then acting administrator of NASA, and DuBridge. U. Alexis Johnson, Under Secretary of State for Political Affairs, Glenn T. Seaborg, Chairman of the Atomic Energy Commission, and Robert P. Mayo, Director, Bureau of the Budget, were named as observers. Nixon directed that the report be submitted to him by September 1, 1969.[95]

DuBridge's influence on the final report appears to have been minimal, certainly less than acting NASA Administrator Thomas Paine. The Space Task Group report called for a human mission to Mars, continued lunar exploration, a space station and a space shuttle. It did not present these as separate options, but part of a whole. It offered different paces and funding requirements for doing essentially the whole plan, presenting Nixon with an all-or-nothing proposition.[96]

Whereas the transition report by the Task Force had specifically recommended *against* setting a goal of sending humans to Mars and instead favored continued lunar exploration, the Space Task Group outlined four different space goals which constituted an extremely ambitious but well-integrated space plan. Whereas James Webb had fought establishing long-range goals without clear expressions of political support, Paine had gotten the panel to endorse an expensive program that clearly ran counter to what the administration wanted. Paine had seen the transition group's report and had even circulated it through NASA in May. He had done so while rejecting its vision of the future of the civilian space program as too limited. Yet Paine failed to recognize that the transition group's report accurately reflected the political agenda of the new administration as far as space was concerned.

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[94] Edgar M. Cortright, Memorandum for Mr. Webb, "NASA-CIT/JPL Relations as they pertain to the present contractual arrangements of operating conditions and the future role of JPL in the NASA Program," June 1964, NASA Historical Reference Collection, and Arnold O. Beckman, Chairman, Board of Trustees, California Institute of Technology, to James E. Webb, Administrator, NASA, June 26, 1964. See also, R. Cargill Hall, *Lunar Impact: A History of Project Ranger* (Washington, DC: NASA SP-4210, 1977), pp. 201-202.

[95] Richard Nixon, Memorandum for The Vice President; The Secretary of Defense; The Acting Administrator, National Aeronautics and Space Administration; and The Science Advisor, February 13, 1969, contained in "White House Files," NASA Historical Reference Collection.

[96] For a further discussion of this report see Dwayne A. Day, "Paradigm Lost," *Space Policy*, November 1995.

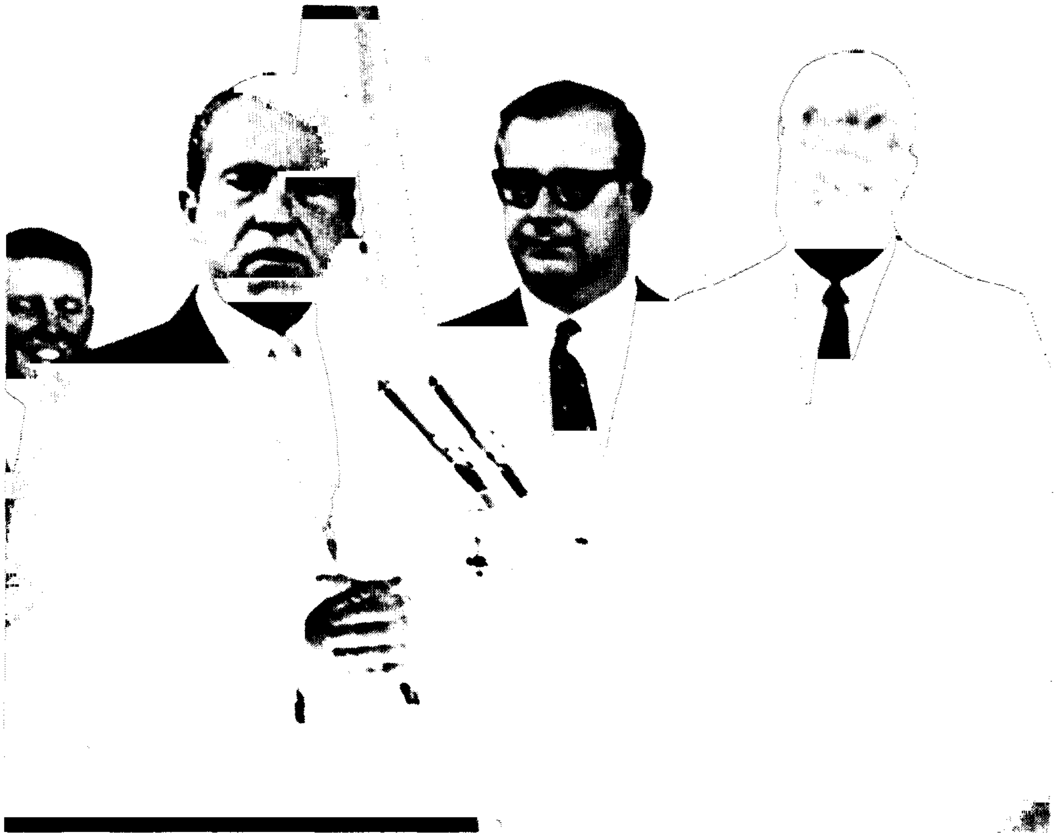

Figure 3 President Richard Nixon charged the National Aeronautics and Space Council to develop a plan for post-Apollo space activities in the Spring of 1969. Here he stands with Thomas O. Paine (Left), NASA Administrator, and Vice President Spiro T. Agnew (Right). Agnew chaired the Space Task Group study, and Paine heavily influenced it toward an aggressive post-Apollo space exploration mission. Photograph from NASA collections.

Once Paine gained primary influence on the direction of the Space Task Group, it was virtually a foregone conclusion that its recommendations would be ignored by the administration. The Space Task Group's report sank virtually without a trace. The space shuttle and space station aspects of the report were accepted, but a firm decision to commit to the shuttle was not made until two years later. The space station fell by the wayside. The integrated plan made no sense once it was taken apart.

Throughout this, the National Aeronautics and Space Council played no role. Not only were most of the traditional members of the Council not a part of the process, but the vice president received advice from both the science adviser's staff and members of NASA, since the NASC lacked an executive secretary and staff. Certainly some of the blame for the outcome of the report, and its disconnect with political reality, was due to the fact that Agnew, who also lacked Nixon's confidence, was operating without effective support. A viable NASC might have been able to better ensure that any recommendations for the future of the space program reflect both budgetary reality and the political concerns of Richard Nixon and his advisors, not simply the interests of the NASA administrator. But it could only have done so if Nixon had placed greater priority on the nature and quality of the advice he received on space.

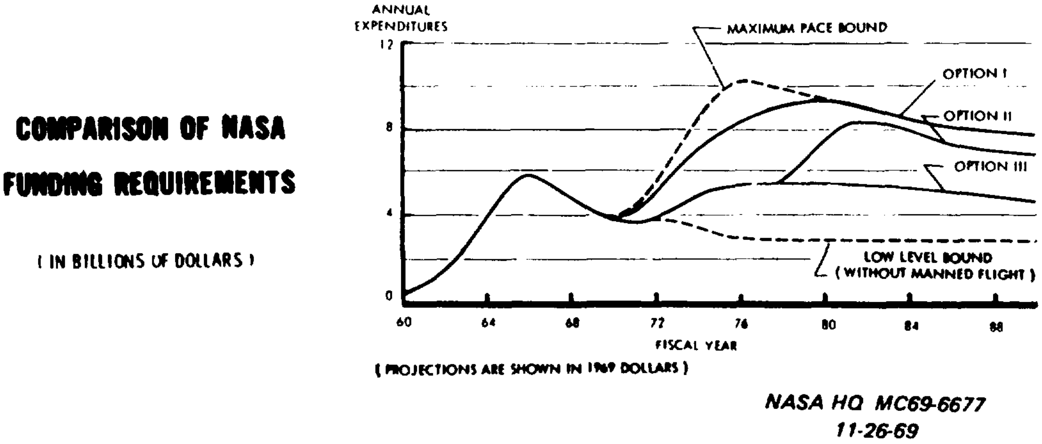

Figure 4 A table from the 1969 Space Task Group Report, this study recommended three options that could be followed in the post-Apollo space effort, each more aggressive than the last. All, however, had essentially the same components and pace was based upon the level of funding required. Photograph from NASA collections.

One of the recommendations of the Task Group's report was that the "Space Council be utilized as a mechanism for continuing reassessment of the character and pace of the space program," echoing the transition team's recommendation.[97] But given that Agnew's name was at the top of an unpopular report early in the process, it was unlikely that the Council could exert much influence with him as Chairman.

The NASC was not formally dead, however. Astronaut William Anders, who had flown on the Apollo 8 mission around the Moon, was appointed by Nixon as Executive Secretary in May 1969, but because he was a member of the backup crew for Apollo 11, he did not assume his position until September, when the Task Group had already submitted its report.[98] Anders had to resign both his NASA job and his Air Force commission to become Executive Secretary.

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[97] *The Post-Apollo Space Program: Directions for the Future*, Space Task Group Report to the President, September 1969, contained in "Space Task Group Files," NASA Historical Reference Collection, p. v.

[98] *Preliminary Inventory of the Records of the National Aeronautics and Space Council*, Record Group 220, Compiled by Jarritus Wolfinger, National Archives and Records Service, Washington, 1977, Introduction, p. 3.

Anders reorganized the Council staff into three groups, the Executive Group, the Space Group, and the Aero Group. While the duties of the aerospace assistants remained essentially unchanged, each was assigned to specific tasks rather than areas of responsibility. At the same time, the secretarial and clerical support staff increased, along with the vice president's support staff, which grew from four to seven.[99] All of this came at a time when the administration was looking for ways to reduce the size of the Executive bureaucracy.

In a letter to the president dated December 4, 1969, Vice President Spiro Agnew said, "When we asked Bill Anders to leave his NASA and USAF career to become Executive Secretary of the National Aeronautics and Space Council he was assured of our support. Our goal was to revitalize the Council and staff since this agency had literally stopped functioning."[100] Agnew further went on to note that the Bureau of the Budget initially endorsed a budget of $877,000 for the Council, but that it was cut back to the 1964 level of $500,000. He then said, "There are now several extremely significant issues involving aeronautics and space that the Council should consider and furnish recommendations on to the Administration. I feel, as do the other members of the Council, that in the future there will be even greater requirement for the services of the Council and its staff to provide balance and focus in the development and maintenance of practical aeronautics and space programs." Agnew then asked that Nixon approve the $877,000 budget request for the Space Council in order to carry out the goals developed by the Space Task Group.[101] This was denied.

For the remainder of its existence, the Council primarily was used to brief President Nixon on current space missions, such as the lunar landings and the crisis of Apollo 13. It played no role in new policy formation. Anders presented viewgraphs and maps to the president detailing what areas of the Moon were being explored and how. Except for the addition of the Secretary of Transportation to the NASC in September 1970, little changed with the Council or its activities.

Anders, like NASA Administrator Thomas O. Paine, did not recognize until too late that President Nixon and most of the top-level members of his staff were almost totally uninterested in space issues. But at least part of the blame for this rests with administration officials who repeatedly refused requests for meetings and were often obscure about their views. George M. Low, who became Deputy Administrator of NASA in 1970, also expressed the difficulty of discerning White House attitudes toward space in a note for the record on Post-Apollo European cooperation. Low recounted his difficulty in obtaining a meeting with Henry Kissinger to discuss cooperation with the Europeans and stated, ". . . it became quite apparent that the domestic side of the White House was very much opposed to the kinds of things that Tom Paine had been do-

[99] *Ibid.*

[100] Vice President to the President, December 4, 1969, White House Special Files, Confidential Files, NASC, Box 14, Nixon Project, National Archives, p. 1.

[101] *Ibid.*, p. 2.

ing."[102] Although Low was referring to White House negativism toward one aspect of the NASA plan, there are other clear instances of lack of support for space in the Nixon White House, including the difficulty Nixon had filling the NASA Administrator's position due to a perceived lack of support for space, the cool reception that the Space Task Group report received and various negative internal memos from staff aides.[103] If the White House was more attuned to space issues, it is likely that it would have taken the advice of its transition team and made the NASC into a viable organization that would have reflected the administration's case for space. But there really was no administration case for space.

After Nixon's reelection in 1972, he proposed the elimination of the NASC as part of a sweeping reorganization of the Executive Office of the President that also included the elimination of the Office of Emergency Preparedness and the Office of Science and Technology. This reorganization was to take effect July 1, 1973.[104] The stated purpose was to reduce the size of the Executive Office of the President out of a view that it had become too large and unwieldy and that it frequently was engaging in the administration of programs that could be better managed by their departments and agencies. According to the 1973 *Aeronautics and Space Report of the President*, "The Council was abolished because the major policy issues of the past have been largely resolved in the national space program, and a special advisory group in the Executive Office of the President was considered no longer necessary. Interagency coordinating arrangements were considered adequate to handle any future issues that may arise."[105]

Although the National Aeronautics and Space Council had been created by public law, there was little doubt that it was entirely within the president's power to eliminate it. The House Committee on Government Operations in its report on the Reorganization

[102] George M. Low, Personal Notes No. 69, May 6, 1972, Box 69, Folder 4, The George M. Low Papers, Rensselaer Polytechnic Institute, p. 4.

[103] There was a strong belief among many of Nixon's advisors that there was little political benefit to be gained from space. For instance, Assistant to the President Peter Flanigan had been designated by Nixon and his top policy advisor, John Ehrlichman, to be the White House link to NASA, bypassing the Space Council. In a December 6, 1969 memorandum to Nixon, Flanigan noted an October 6 *Newsweek* poll which found that 56 percent of the country's population with incomes from $5,000 to $15,000 a year thought that the government was spending too much on space. Flanigan noted that only 10% thought that the government should be spending more money. Peter M. Flanigan, Memorandum for the President, December 6, 1969, contained in "White House Files," NASA Historical Reference Collection. Presidential advisors also felt a need to protect and insulate Nixon from space issues. See, for instance, a memo from H.R. Haldeman to Ehrlichman, dated April 19, 1970 where Haldeman stated: "Just as a warning, I wanted you to know that the President spent about an hour and a half on the plane from Houston to Hawaii talking with Tom Paine about the whole future of the space program. You and/or Flanigan will probably want to follow up on this and find out what the President said to Paine. He met with him alone." H.R. Haldeman, Memorandum for Mr. Ehrlichman, April 19, 1970, White House Central Files, Central File Group 164, Box 1, Nixon Project, National Archives.

[104] "Reorganization Plan No. 1 of 1973," Presidential Documents, Richard M. Nixon, 1973.

[105] NASA, *Aeronautics and Space Report of the President: 1973 Activities* (Washington, DC: NASA Annual Report, 1974), p. 7. It should be noted that the NASC was formerly in charge of preparing the President's report on United States aeronautics and space activities.

Plan stated, "As a practical proposition, the President cannot be compelled to utilize a policy-making and advisory apparatus in the Executive Office against his own preferences."[106] It also stated that the Committee had recommended almost eight years earlier, in July 1965, that the NASC be given increased presidential support, staff and resources in order to carry out its duties as outlined in the National Aeronautics and Space Act. But the Council had frequently been bypassed or ignored as special interagency groups had been established to handle specific issues. "The NASC was limited from the outset by the development of alternative coordinating mechanisms more closely attuned to operating requirements."[107] Finally, the report stated that vice presidents also utilized Council staff for other, non-aeronautics or space, issues. The House Committee concluded reluctantly, but realistically, that the existence of such an organism made no sense if the president did not want it.

Conclusion

Proponents of reviving the Space Council in the 1980s argued that an Executive-level body is necessary to serve as an advocate for space issues with the president. Yet this is one of the reasons that a president may be reluctant to establish such an agency—he does not wish to be lobbied by governmental interests within the White House. The dramatic difference in tone between the November 1962 evaluation of the space program by the Bureau of the Budget and the May 1963 evaluation by the NASC highlights the fact that it is easy for such an Executive Branch advisory body as the NASC to cross the line from advice to advocacy.

If the primary concern is to keep the president informed of space issues, then that task is easily provided for by both NASA and DOD. The charge has frequently been raised that neither agency is capable of providing unbiased information to the president and that the NASC is needed as an impartial observer. But its ability to serve effectively in that capacity is a direct offshoot of the confidence, attention and power given to it by the Chief Executive. Both DOD and NASA will ignore such a body if they feel free to do so. Finally, given that the organization had no clear authority over policy direction for either civilian or military space and that presidents frequently went directly to the operating agencies themselves for information, its role as an impartial observer was unimportant. Eisenhower was right, policy formulation should reside in the agency charged with carrying the policy out except in specific instances when it is deemed important to formulate policy elsewhere. If the president wishes to impose his will on that policy formulation, he has other means of doing so. He also has the means of imbuing a NASC or similar body with the power to reflect his views. But the mere creation of a body, especially by an outside party such as the Congress, will not automatically improve the process.

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[106] "Reorganization Plan No. 1 of 1973," Second Report by the Committee on Government Operations, 93d Congress, 1st Session, House Report No. 93-106, April 4, 1973, p. 18.

[107] *Ibid.*, p. 19.

While all this is true, there is a case, albeit a weak one, to be made for such a body. NASA is an unusual organization in the federal government because of the fact that it has only three political appointees. Other agencies of similar size and budget, such as Energy, have far more top officials directly appointed by the president. This situation was less of a problem in the early years of the space program when presidents were able to exert greater control over the direction of the agency. However, by the end of the 1960s, NASA had an entrenched bureaucracy and was increasingly subject to the will of Congress. Its program plans began to diverge from presidential agendas. A strong NASC, staffed by competent people who understood the president's philosophy and had the support of the president, could serve to exert greater influence over the civilian space program. But once again, this underlines the truism that, in order for the system to work, the president has to care about the issue. If space is unimportant to the president, a policy advisory board will have little influence. Throughout most of the history of the National Aeronautics and Space Council, this proved to be the case.

Chapter 7

The United States Air Force Organizes for Space: The Operational Quest

Rick W. Sturdevant[1]

During activation ceremonies for Space Command on September 1, 1982, General James V. Hartinger expressed his pride at being selected the first commander. Labeling its establishment "a crucial milestone in the evolution of military space operations," he predicted the new command would "provide the operational pull to go with the technology push which has been the dominant factor in the space world since its inception."[2]

The Inception of Military Space Policy

A necessary precursor to any Air Force operations in space, the "technology push" to which Hartinger alluded had been promoted as early as the mid-1940s by a number of "young Turks" and assorted others with engineering or scientific back-

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[2] Gen. James V. Hartinger, SPACECMD/CC, "Remarks on the Activation of the Space Command," September 1, 1982. General Charles A. Gabriel, Air Force chief of staff, used strikingly similar language at almost the same time to explain Space Command's creation. He said it was "mostly . . . a consolidation of what we had in being. A new way to organize with the operational beacon as opposed to just [a] technological driver. The operational will now be the driver. . . . What we have done is pull together the operational and technical—technological push was what we had before." Quoted in Robert Frank Futrell, *Ideas, Concepts, Doctrine: Basic Thinking in the United States Air Force, Volume II (1961-1984)* (Maxwell AFB, AL: Air University Press, 1989), p. 698.

grounds. Those individuals envisioned development, production, and procurement of a space launch capability and satellite vehicles making possible delivery of unprecedented support to U.S. military forces through space-based systems. They pursued this goal relentlessly, despite opposition from within the Air Force itself as well as competition from the Army and Navy.

Seeking to preserve or enlarge their respective roles and missions, the three services—Air Force, Army, and Navy—engaged in a sometimes fierce rivalry for the military space research-and-development (R&D) crown. The competitive saga began in summer 1943, when Colonel W. H. Joiner, Army Air Forces (AAF) Materiel Command liaison officer at the California Institute of Technology, suggested that Frank J. Malina and Hsue-shen Tsien survey the potential of long-range rockets. Theodore von Kármán, who forwarded the resulting report (under his own very positive cover memo) to the services on November 20, 1943, expressed surprise when the AAF failed to respond. Shortly, the Army Service Forces (ASF) Ordnance Department, with Materiel Command's acquiescence, contracted with Caltech in January 1944 for development of a long-range, surface-to-surface rocket to match or exceed the performance of Germany's V-2.[3]

Concern that the Ordnance Department's long-range rocket work threatened the AAF's strategic bombardment mission led the Air Staff to ask, in September 1944, that the War Department General Staff assign *all* guided missile R&D, including joint service projects, to the AAF. On October 2, 1944, Lieutenant General Joseph T. McNarney, Army deputy chief of staff (and an AAF officer), gave the AAF R&D responsibility, but only for air- and surface-launched missiles that depended on aerodynamic lift for sustained flight (not long-range ballistic missiles). The next two years brought complaints from scientific and industrial leaders about the waste of money, personnel, and resources through duplication of effort and fear that the Navy might seize the initiative in space. Consequently, on October 7, 1946, the Army rescinded the McNarney directive and assigned all of its missile R&D management to the AAF. The General Staff director of R&D was designated as referee to ensure the AAF did not favor its own requirements over others. In an arrangement that apparently worked very well, the AAF Technical Committee determined priorities and assigned individual projects to various Army agencies until March 1948, six months after creation of the United States Air Force (USAF) as a separate military department.[4]

Meanwhile, an intense rivalry had emerged within the AAF itself. One faction blamed the AAF's laggardly missile development effort on organization along functional lines under the Air Staff assistant chief for materiel and services. That faction favored a more centralized management structure to focus sufficient attention on missile programs. In September 1943, Air Staff Air Communications Officer Brigadier General Harold M.

[3] Jacob Neufeld, *The Development of Ballistic Missiles in the United States Air Force, 1945-1960* (Washington, DC: Office of Air Force History, 1990), p. 42; Michael H. Gorn, *The Universal Man: Theodore von Kármán's Life in Aeronautics* (Washington, DC: Smithsonian Institution Press, 1992), pp. 94-95; Theodore von Kármán, with Lee Edson, *The Wind and Beyond: Theodore von Kármán, Pioneer in Aviation and Pathfinder in Space* (Boston: Little, Brown and Company, 1967), pp. 264-65.

[4] Neufeld, *Ballistic Missiles*, pp. 18-23.

McClelland won, for his organization, the authority to "monitor, coordinate and expedite" the AAF's entire missile effort by overseeing "requirements, development, experiment and procurement."[5]

In January 1945, AAF missile responsibilities returned again to regular functional channels, with the Assistant Chief for Operations, Commitments and Requirements setting new requirements and the Assistant Chief for Materiel and Services overseeing R&D. The issue of centralized versus functional control persisted into the postwar period. Major General Curtis E. LeMay, appointed by General Henry "Hap" Arnold as the first Air Staff Deputy Chief of Staff for Research and Development, continued to advocate centralization as the best way to meet interservice competition from the ASF's Ordnance Department. The aforementioned assistant chiefs and their followers successfully argued, however, that postwar technological limitations and financial constraints dictated orderly, *evolutionary* missile development and procurement within traditional Air Staff channels. They wanted nothing to do with a *revolutionary* (centralized and innovative) approach to managing Air Force R&D.[6]

Space Policy in the Immediate Post-War Era

Organizational squabbling became more acrimonious with establishment of an independent Air Force and creation of the Department of Defense in 1947. Even before then, in April 1946, General LeMay had directed Douglas Aircraft Company's Project RAND to examine the feasibility of man-made earth satellites, because he believed the AAF should demonstrate competence equal to the Navy's in space R&D. The RAND group had completed its basic study before the end of May 1946 and released twelve more detailed studies in February 1947 supporting the feasibility of a space program.[7]

It did not take the Air Force long to act on RAND's findings and to assert itself in the realm of R&D for space systems. Air Materiel Command's Engineering Division finished evaluating the RAND studies near the end of 1947 and recommended the Air Force establish a satellite project. On December 19, 1947, the Joint R&D Board, by then a policy body, agreed the Air Force should be the only service authorized to spend Defense Department funds on earth satellite studies. Air Force vice chief of staff Gen-

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[5] *Ibid.*, p. 13.

[6] *Ibid.*, pp. 17-18; Michael H. Gorn, *Harnessing the Genie: Science and Technology Forecasting for the Air Force, 1944-1986* (Washington, DC: Office of Air Force History, 1988), pp. 42-50.

[7] Merton E. Davies and William R. Harris, *RAND's Role in the Evolution of Balloon and Satellite Observation Systems and Related U.S. Space Technology* (Santa Monica, CA: RAND Corporation, 1988), pp. 6-17; Robert Kipp, HQ AFSPACECOM/HO, "Trends in Military Space: Organizational Growth and Maturity," May 30-31, 1990, p. 2. Unless otherwise noted, all unpublished documents are available in the History Office of Air Force Space Command, Peterson Air Force Base, CO. For a detailed assessment of how the Air Force used contracting in an effort to catch up with the Navy's and Army Ordnance's space research programs, see David H. DeVorkin, *Science With A Vengeance: How the Military Created the US Space Sciences After World War II* (New York: Springer-Verlag, 1992), pp. 87-94.

Figure 1 Gen. Henry H. "Hap" Arnold, Commanding General of the U.S. Army Air Forces in World War II, encouraged the development of rocket technology during the 1940s. Photograph from USAF collections.

eral Hoyt S. Vandenberg unilaterally signed a policy statement on January 15, 1948, that became the first clear statement of space program interest by any service. Declaring that the Air Force had "logical responsibility for the satellite," it enunciated USAF policy on

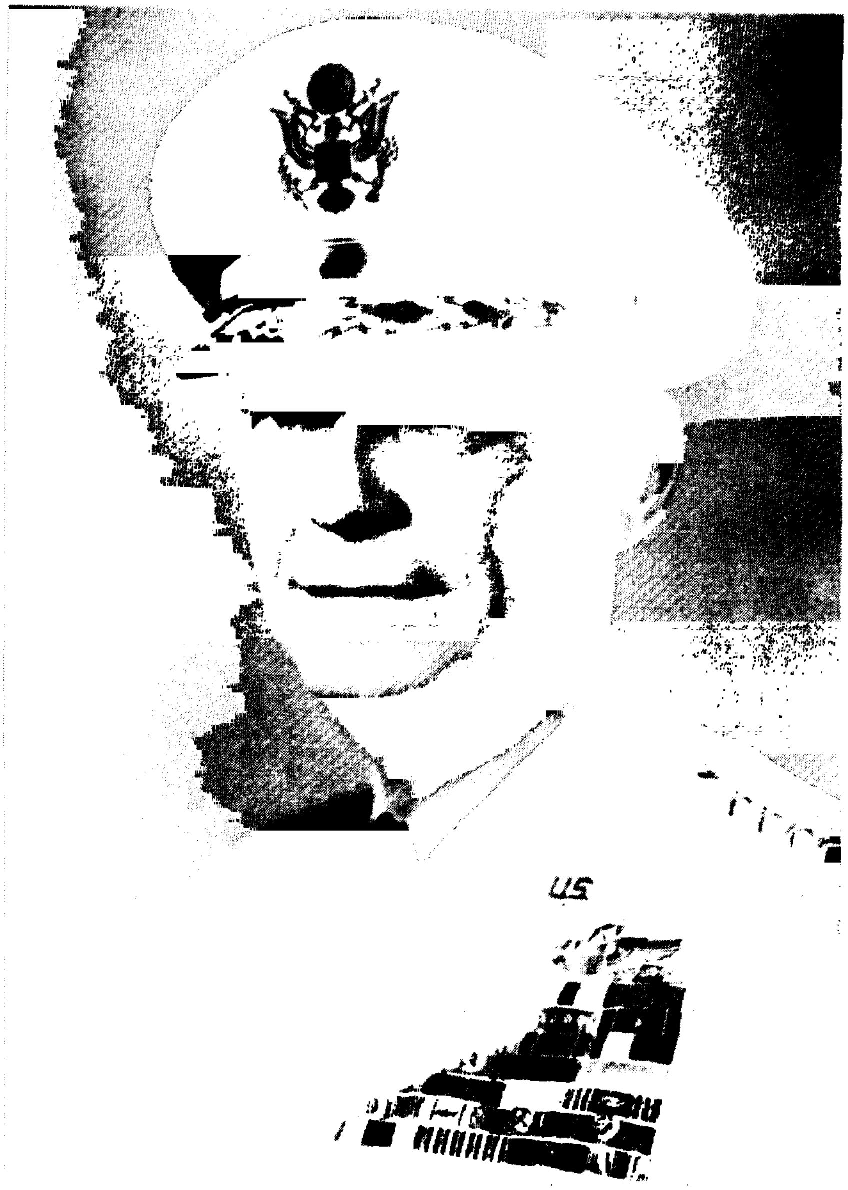

Figure 2 Gen. Joseph T. McNarney, as U.S. Army Deputy Chief of Staff in October 1944, assigned responsibility for air-launched and certain surface-launched missiles to the U.S. Army Air Forces. Photograph from USAF collections.

satellite R&D. When the Air Staff director for R&D forwarded that policy to Materiel Command's Engineering Division the following day, that organization interpreted it as a green light for authorizing further RAND satellite studies.[8]

Submission of RAND's reports on satellites for meteorology and reconnaissance (Project Feed Back) in April 1951 coincided with designation of autonomous status for the year-old Air Research and Development Command (ARDC) as well as increased stature for the USAF Headquarters (HQ), Deputy Chief of Staff (DCS) for Development. Such organizational changes signaled a shift from overemphasis on the procurement and production aspects of the materiel function in the immediate postwar years to renewed emphasis on R&D. Although ARDC soon decided the Air Force itself should manage subcontracted RAND studies to better integrate satellite development efforts with recently reactivated Atlas ballistic missile efforts, HQ USAF did not instruct ARDC to begin "active direction" of the entire Feed Back Program until May 22, 1953. To further unify its management of the satellite R&D effort, ARDC pulled all the proliferating aspects into what it tentatively identified as Project 409-40, "Satellite Component Study," during the closing months of 1953. Furthermore, ARDC unofficially assigned the project a system development designation as "Weapon System 117L." When HQ ARDC ordered Wright Air Development Center to press ahead with demonstration of the feasibility of major satellite components on December 3, 1953, the project was transferred to the Bombardment Missiles Branch at Wright Air Development Center.[9]

Developing a Military Space Capability

Transition of the Air Force space effort from research project to developmental system during the early 1950s was facilitated by the emergence of a group of scientific advisors. The scientists better understood the technical gravity of the Soviet atomic threat and were more willing to consider unconventional responses to counter that threat. At the same time, however, a new Defense Department "economy drive" led Secretary of Defense Charles E. Wilson to direct on June 16, 1953, that a Guided Missiles Study

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[8] Lee Bowen, USAF History Division Liaison Office, "The Threshold of Space: The Air Force in the National Space Program, 1945-1959," September 1960, pp. 4-5, 16; Robert Frank Futrell, *Ideas, Concepts, Doctrine: Basic Thinking in the United States Air Force, Volume I (1907-1960)* (Maxwell AFB, AL: Air University Press, 1989), p. 541; Bruno W. Augenstein, "Evolution of the U.S. Military Space Program, 1945-1960: Some Key Events in Study, Planning, and Program Development," (RAND Paper Series, P-6814), September 1982, p. 5; Walter A. McDougall, . . . *the Heavens and the Earth: A Political History of the Space Age* (New York: Basic Books, 1985), pp. 97-111.

[9] Michael H. Gorn, HQ AFSC/HO, "Vulcan's Forge: The Making of an Air Force Command for Weapons Acquisition (1950-1985), Volume I (Narrative)," pp. 15-18; Alfred Goldberg, ed., *A History of the United States Air Force, 1907-1957* (Princeton, NJ: D. Van Nostrand Company, 1957), pp. 197-98; Augenstein, "Evolution of the U.S. Military Space Program," pp. 5-8; Jacob Neufeld, ed., *Reflections on Research and Development in the United States Air Force* (Washington, DC: Center for Air Force History, 1993), pp. 35-51; Davies and Harris, *RAND's Role in the Evolution of Balloon and Satellite Observation Systems and Related U.S. Space Technology*, pp. 47-48.

Group, under the Armed Forces Policy Council, review and recommend cost-cutting measures in the missile program through standardization wherever possible. The Guided Missiles Study Group, in turn, created a special subcommittee known as the Strategic Missile Evaluation or "Teapot" Committee under Dr. John von Neumann's chairmanship. The "Teapot" Committee concluded that recent advances in rocket technology and warhead development made an intercontinental ballistic missile (ICBM) not only feasible but useful. A series of implementation recommendations reached Trevor Gardner, Air Force Assistant Secretary for Research and Development, in early 1954. He and von Neumann won support from Air Force Chief of Staff General Nathan F. Twining and Air Force Secretary Harold E. Talbott. By July 1954, the Air Force had created a field organization, engaged contractor support, and sketched the broad outlines of a complex ballistic missile development program.[10]

Air Force leaders also began looking more intently toward successful mating of launch systems with satellite vehicles, without which there could be no extended operational use of space for such things as reconnaissance, attack warning, meteorology, or communication. General Curtis LeMay, commander of Strategic Air Command (SAC), already had urged his staff to prepare a requirements document for a satellite vehicle, but they had delayed. Improved refueling techniques and manned bombers had been higher on their list of priorities. That delay, however, did not deter successive ARDC commanders, Lieutenant General Donald L. Putt and Lieutenant General Thomas S. Power, from enthusiastically supporting satellite development. The cause gained momentum in October 1954 after Trevor Gardner asked the ICBM Scientific Advisory Group, an outgrowth of the earlier "Teapot" Committee, to review the relationship among satellite proposals, other missile proposals, and the rapidly unfolding ICBM program. Completion of the review ultimately became the responsibility of ARDC's Western Development Division (WDD), another product of the "Teapot" Committee, which had been established July 1, 1954, to accelerate USAF ballistic missile development. The WDD recommended it be assigned management of the satellite program to facilitate coordination with the large rocket programs already under its oversight, which made sense from a technological as well as an engineering perspective.[11]

Despite that reasoning, the ICBM Scientific Advisory Group, ARDC commander Lieutenant General Power, and his vice commander Major General John W. Sessums, Jr., mutually agreed as early as January 1955 that work on the satellite vehicle should proceed independently without interference from, or with, the ballistic missile program. Furthermore, WDD commander Brigadier General Bernard A. Schriever and his staff preferred to devote their principal attention to the ICBM and feared that satellite responsibilities might detract from their efforts, unless adequate additional resources came with the satellite development mission. Given the fiscal climate in 1955—President Eisenhower's determination to balance the budget at all costs—the prospects for obtaining extra materiel and personnel seemed next to impossible. Consequently, management of

[10] Neufeld, ed., *Reflections*, pp. 53-60.

[11] Robert L. Perry, DCAS History Office, "Origins of the USAF Space Program, 1945-1956," August 1962, pp. 40-45.

the satellite program was assigned initially to Wright Air Development Center (WADC) under Lieutenant Colonel Q.A. Riepe and, subsequently (after August 1955), under Lieutenant Colonel William G. King, Jr. In May 1955, however, Brigadier General Howell M. Estes, Jr., WADC's director of Weapon Systems Operations, told HQ ARDC it could minimize duplication of effort and save substantial money through "direct and continuous liaison" with WDD. Similarities in specific R&D features of the satellite and ICBM programs would permit consolidation and sharing of data. Detachment 1 of ARDC was established at Wright-Patterson Air Force Base on August 20, 1955, to provide such liaison. On October 10, 1955, General Power ruled that Weapon System 117L would transfer from WADC to WDD, and his staff published amended System Requirement No. 5 seven days later to confirm the transfer of planning and management responsibility. Nevertheless, final details went unsettled until a January 13, 1956, formal memorandum of understanding. General Power reasoned that the best way to ensure that satellite programs would not interfere with ICBM development was to have the same organization manage both.[12]

Although actively pursuing a satellite capability, Air Force policy dictated public silence on military space matters. It came as a surprise, therefore, when General Schriever stood before nearly a thousand scientists, engineers, and reporters at the first Annual Astronautics Symposium in San Diego, California, on February 19 and declared the U.S. was on the very brink of moving far into space and ought to establish "space superiority" for national safety. His superiors quickly muzzled Schriever, because the Eisenhower administration's avowed policy favored international controls to secure a peaceful, nonmilitary use of space![13]

The Soviet Union's launch of Sputnik, the first human-made earth satellite, on October 4, 1957, significantly changed the environment for Air Force space endeavors. Amidst a barrage of criticism from the media and widespread shock among the general populace that the Soviet Union had beaten the U.S. into space, Air Force leaders sought to define an orderly program to recoup the nation's damaged prestige. They vigorously promoted the Air Force claim to space as a natural extension of the air arm's operational medium. In a December 1957 policy statement directed at Congress, the Air Force asserted it was organized "to provide the specialization needed for operation above the surface of the earth" and, though relatively young as a service, already possessed "the preponderant capability, competence and operating experience necessary for the accelerated development of space vehicles." With twelve ARDC centers "devoted to the various aspects of space operations, such as personnel training requirements, space medi-

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[12] Interview, Brig. Gen. William G. King, Jr., (USAF, Ret) by George W. Bradley and Herbert M. Zolot, HQ AFSPACECOM/HO, August 30, 1993; AFBMD/HO, "Air Force Ballistic Missile Chronology, 1946-1957," p. 12.

[13] Martin Caidin, *War for the Moon* (New York: E.P. Dutton, 1959), pp. 69-73; Neufeld, *Ballistic Missiles*, p. 181; Futrell, *Ideas, Concepts, Doctrine*, 1:549-50.

Figure 3 Dr. John von Neumann, a brilliant mathematician and head of Princeton's Institute for Advanced Study, chaired the Teapot Committee, which in February 1954 recommended to the Air Force new organizational and management strategies for accelerated development of an ICBM. Photograph from USAF collections.

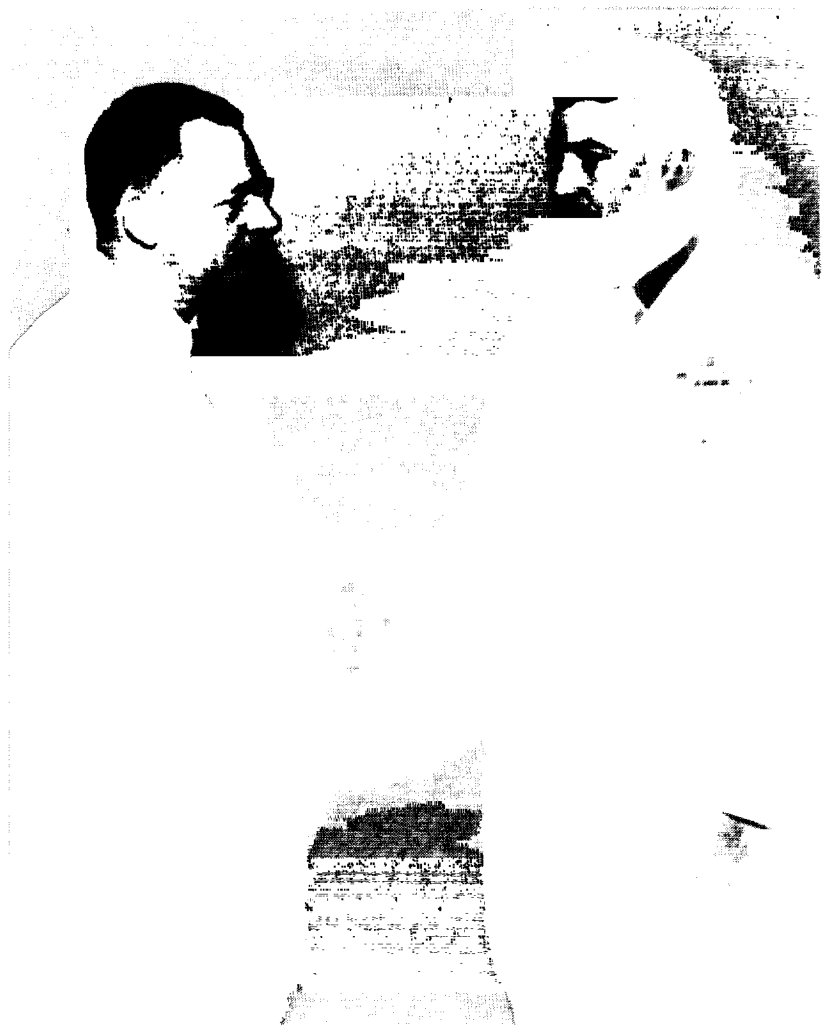

Figure 4 Air Force Assistant Secretary for Research and Development Trevor Gardner and Western Development Division commander Maj. Gen. Bernard A. Schriever were committed to implementing the Teapot Committee's recommendations. Photograph from USAF collections.

cine, propulsion, geophysics, communications, guidance and test operation," Air Force leaders were confident they could handle the Soviet challenge.[14]

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[14] Memo by Brig. Gen. Homer A. Boushey, Dep Dir/R&D, DCS/Development, USAF, to Spec Asst to Chief of Staff, USAF, "Missile Hearing," December 6, 1957, w/5 Incl, cited in HQ AFSC Historical Division, "Proposal for Man-in-Space (1957-1958) by Air Research and Development Command" (AFSC Historical Publication Series 66-11-1), pp. 77-78, Air Force Space Command History Office.

Well before the Sputnik launch, ARDC had begun scrutinizing its own organization to determine its appropriateness for the space age. A "Committee for the Review and Evaluation of Center Missions," which had been created in August 1957, still was working on its task when the furor arose over the Soviet satellite. Many informed observers and participants liked the idea of a "space center" that would function for satellite projects like the Air Force Ballistic Missile Division (WDD's redesignation effective June 1, 1957) did for missiles. At an ARDC council session on November 14, 1957, Colonel Gordon T. Gould, Jr., from the Air Defense Systems Management Office advocated immediate establishment of a "space center" on grounds that the Air Force could no longer afford a "bits and pieces" approach to missile and satellite problems that were growing larger and more complex. Subsequent council deliberations focused on creation of an "Astronautical Center" at Holloman AFB, New Mexico, under General Schriever's leadership. Although Air Staff supported creation of the center, Deputy Defense Secretary Donald A. Quarles ultimately disapproved because he opposed spending $40 million for new buildings to house it.[15]

Meanwhile, the "Guided Missile and Space Vehicle Working Group," originally formed in December 1956 by ARDC commander Lieutenant General Thomas S. Power, met in early December 1957 to prepare guidelines for "an aggressive space technology program." Brigadier General Marvin C. Demler, ARDC deputy commander for R&D, reinforced the working group's report in a December 17, 1957, letter to his subordinates. He directed a programmatic reorientation to ensure "revolutionary" advances in space technology and, thereby, render related evolutionary "operational or component development" projects obsolete. Major General John W. Sessums, Jr., ARDC vice commander, forwarded essentially the same instructions for implementation of a five-year, top-priority "space technology" program to the Ballistic Missile Division and all the command's centers on December 20, 1957.[16]

The flurry of activity continued into 1958 amidst growing apprehension that the Air Force might lose control of its space program to some new Defense Department or civilian space organization supported by the White House. On January 7, 1958, the first day of a "Space Technology Conference" at Baltimore's Southern Hotel, General Sessums told over 330 delegates that he did not know what organizational changes might be needed to manage the astronautics program, but he suspected it would be managed from headquarters with assignment of specific aspects to whichever centers were most qualified to handle them. Following two days of panel meetings and reports, Lieutenant Colonel Edward A. Hawkens from HQ ARDC's programming office concluded that a sense of urgency dictated reduction in the number of program areas and might necessitate changes in management structure, but he cautioned against overemphasizing reorganization.[17] Even before the conference ended, however, President Eisenhower told the American people in his "State of the Union" address that the secretary of defense had

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[15] *Ibid.*, pp. 78-80.

[16] *Ibid.*, pp. 83-84.

[17] *Ibid.*, pp. 90-98.

"decided to concentrate into one organization all the anti-missile and space technology undertaken within the Department of Defense." Indeed, Secretary of Defense Neil H. McElroy had declared his intention to create such an agency as early as November 27, 1957, and Eisenhower's science advisor James Killian had reinforced that intent in the president's mind on December 30 by asserting that "modernization of organization is the single most important factor in improving our defense technology."[18] The Advanced Research Projects Agency (ARPA) was established officially on February 7, 1958, with responsibility for all space projects—scientific and military.[19]

From its inception, ARPA had highly placed detractors within the Air Force. Lieutenant General Samuel E. Anderson, ARDC commander, had told Southern Hotel conference participants that McElroy's decision meant the Air Force must emphasize its heritage and technical capabilities more aggressively in order to "sell" its spaceflight program to the Pentagon. On January 9, 1958, General Schriever had appeared before a Senate subcommittee and warned that "any program to establish a separate astronautics management agency would result in duplication of capabilities already existing in the Air Force ballistic missile programs at a cost in funds and time similar to that already expended on these programs."[20] Three months later, he reiterated his point by arguing the Air Force could initiate an astronautic development program "with no dilution or diversion" of its ballistic missile efforts, because it had "a vast military, scientific and industrial organization experienced in the design, development, testing and production of ballistic missiles."[21] During spring 1959, Schriever and Under Secretary of the Air Force Malcolm A. MacIntyre told the Senate Subcommittee on Governmental Organization for Space Activities that management of R&D for space systems ought to revert to the services that would operationally employ those systems. Schriever complained that ARPA's separation of R&D from operations prevented application of the "concurrent development" strategy he had employed to significantly reduce the time it took to achieve an initial operational capability with ballistic missiles.[22]

Although ARPA did constrain the activities of the individual services by overseeing the entire military space effort, the Air Force could have suffered a worse fate. In the weeks following the Sputnik launch, several high-level officials had advised Eisenhower on how the nation might reduce what he and many others perceived as the wasteful, damaging impact of interservice rivalry on the achievement of an operational space capability. Nelson Rockefeller, who chaired a special Advisory Committee on Govern-

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[18] Robert A. Divine, *The Sputnik Challenge: Eisenhower's Response to the Soviet Satellite* (New York: Oxford University Press, 1993), p. 87.

[19] Futrell, *Ideas, Concepts, Doctrine*, 1:589-90; McDougall, . . . *the Heavens and the Earth*, pp. 157-76; Divine, *Sputnik Challenge*, pp. 100-101; Paul B. Stares, *The Militarization of Space: U.S. Policy, 1945-1984* (Ithaca, NY: Cornell University Press, 1985), p. 41.

[20] Futrell, *Ideas, Concepts, Doctrine*, 1:590.

[21] Theodore J. Gordon and Julian Scheer, *First Into Outer Space* (New York: St. Martin's Press, 1959), p. 35.

[22] *Ibid.*, 1:591-92; Bowen, "Threshold of Space," pp. 22-28.

Figure 5 As Air Force Chief of Staff in 1960, Gen. Thomas D. White authorized Bernard Schriever to formulate a space mission and organizational structure for the military use of space for the next decade. Photograph from USAF collections.

ment Reorganization, and Percival Brundage, Director of the Budget, had received an enthusiastic hearing from the president when they recommended creation of unified commands to shift "operational responsibilities" out of the services and directly under the Joint Chiefs of Staff. The services would have been relegated to mere support or logistical roles. Eisenhower knew, however, that he could not single-handedly force the issue, especially after JCS chairman General Nathan Twining, Air Force Chief of Staff General Thomas White, and Chief of Naval Operations Admiral Arleigh Burke joined ranks against the Rockefeller-Brundage proposal. Still, the president insisted on getting "the broad principles of organization right, not bowing to pressures,"[23] and steadfastly

[23] Divine, *Sputnik Challenge*, pp. 101-102.

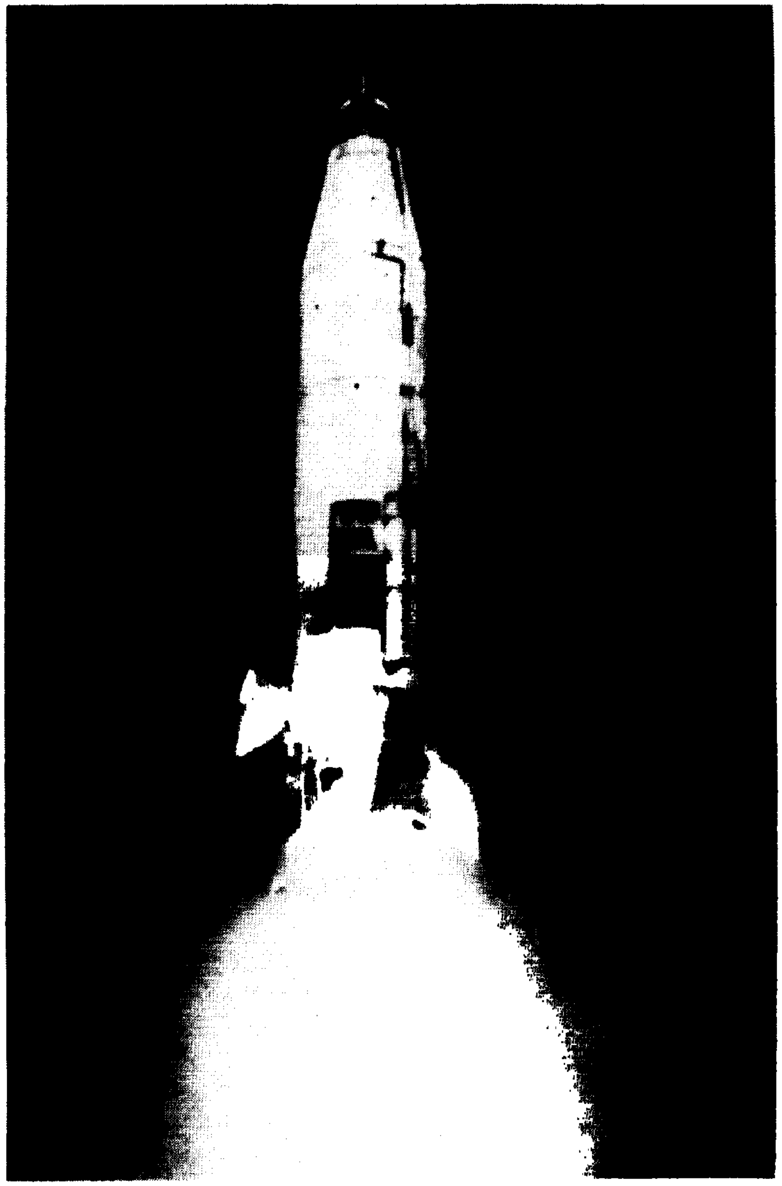

Figure 6 The Atlas ICBM gave the Air Force an effective spacelift capability. This launch from Cape Canaveral in January 1958 was among the earliest test flights. Photograph from USAF collections.

opposed any dissolution of the Defense Department's overall responsibility for missile and space programs. Believing it had been a mistake to leave the missile program in the services rather than to assign it directly to the Office of the Secretary of Defense, Eisenhower adamantly refused during late 1957-early 1958 to give the satellite program to any particular service.[24]

During this period, senior Air Force officers like Generals Twining and White actually supported the unified command concept. Their opposition to actual creation of a new, unified military organization for space operations sprang from fear that it would preempt their own service's campaign for the space mission. General White even advocated centralizing authority over space operations as essential for controlling space. In a major speech to the Air Force Association's Third Jet Age Conference in February 1958, White described air and space as an indivisible field of operations, with Air Force progress toward a space capability being an evolutionary process in which aeronautics and astronautics were closely allied. He warned, "Once we attain the space capability, a lack of centralized authority would certainly hamper our peaceful use of space and could be disastrous in time of war. . . . In war, when time is of the essence and quick reaction so necessary, centralized military authority will surely be mandatory."[25] That centralization, however, seemed to fall logically under the Air Force because, as White explained, "[A]ir and space comprise a single continuous operational field" called "aerospace," in which "[t]he forces of the Air Force comprise a family of operating systems—air systems, ballistic missiles, and space vehicle systems."[26] Thus, as late as mid-1959, the Air Force opposed a new round of Army and Navy initiatives for a JCS-level operational space command.[27]

Of course, the creation of the National Aeronautics and Space Administration (NASA), which replaced the old National Advisory Committee for Aeronautics (NACA), on October 1, 1958, confirmed some of the services' worst fears. Although NASA would be the nonmilitary organization for space, it necessarily had to incorporate preexisting military programs and facilities like the Naval Research Laboratory's Vanguard Program, the largely Army-funded Jet Propulsion Laboratory (JPL) at the California Institute of Technology, and half of the Army Ballistic Missile Agency's Development Operations Division at Huntsville, Alabama. These, along with NACA's facilities and a newly authorized Goddard Space Flight Center, gave NASA the resources needed for peaceful, scientific space exploration. Conversely, among the services, only the Air Force retained sufficient resources to single-handedly pursue development of space systems for military purposes. With the Army and Navy smarting from NASA's raid on their assets, and the relatively unscathed Air Force hoping to capitalize on the situation, overall military organization for space remained a bureaucratic conundrum.[28]

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[24] *Ibid.*, pp. 86-89; Stares, *Militarization of Space*, pp. 41-42.

[25] Futrell, *Ideas, Concepts, Doctrine*, 1:551-53.

[26] *Ibid.*, 1:554; HQ AFSPACECOM/HO, "White and Aerospace," June 4, 1984, Air Force Space Command History Office.

[27] Stares, *Militarization of Space*, pp. 43-44.

[28] McDougall, . . . *the Heavens and the Earth*, pp. 196-200; Divine, *Sputnik Challenge*, pp. 186-91; Stares, *Militarization of Space*, pp. 42-44.

Creation of the Advanced Research Projects Agency (ARPA) had, if anything, increased interservice rivalry and duplication of effort. Early in 1959, Air Force Ballistic Missile Division (AFBMD) commander Lieutenant General Bernard Shriever argued that ARPA should be dissolved, and the Air Force should form a separate acquisition command in preparation for assuming the entire U.S. military space mission. Although General White, Air Force chief of staff, nixed creation of the separate command, his service soon won the bulk of the military space R&D effort. On September 18, 1959, Defense Secretary McElroy officially announced transfer of responsibility for specific space projects from ARPA to the various services, approximately 80 percent (including development, production, and launch of space boosters as well as systems integration of payloads incident to that activity) going exclusively to the Air Force. In that same announcement, McElroy further reinforced Air Force domination of the military space mission by declaring that the foreseeable future did not hold enough space projects to justify "establishment of a joint military organization with control over operational space systems."[29]

McElroy's decision failed to squelch all Army support for a unified space command. On February 18, 1960, Major General John B. Medaris, recently retired commander of the Army Ordnance Missile Command, told a House committee the Army and Navy should neither have to "buy" space boosters from the Air Force nor submit problems associated with wedding vehicles and payloads to settlement "by such anemic devices as committees, coordination officers, and other such inadequate administrative devices."[30] Medaris favored, instead, creation of a single missile-space agency as a unified command within the Defense Department. When asked to reconsider McElroy's decision, however, newly appointed Defense Secretary Thomas S. Gates also determined, on June 16, 1960, that a joint military organization for control of operational space systems was neither immediately necessary nor desirable. He directed the services to provide for the orderly transfer of individual space systems, once operational, to appropriate unified or specified commands.[31]

Military Space Activities in the 1960s

On March 6, 1961, newly appointed Defense Secretary Robert McNamara, seeking clearer assignment of R&D responsibility for military space systems, issued DOD Directive 5160.32 affirming assignment of the military space program to the Air Force on condition the service adjusted its organization to accommodate the task more effectively. The response seemed unusually prompt. On March 17, the Air Force announced that a new Systems Command would replace ARDC effective April 1, 1961, in an effort to clearly separate responsibility for acquisition of new systems from responsibility for

[29] Stares, *Militarization of Space*, pp. 43-44.

[30] Futrell, *Ideas, Concepts, Doctrine*, 1:603.

[31] *Ibid.*, 1:593-94; Stares, *Militarization of Space*, pp. 43-44.

logistical support of existing operational systems. Furthermore, AFBMD was split into Ballistic Systems Division and Space Systems Division (SSD) to improve the focus on space R&D, which was significantly smaller in scope than missile R&D.[32]

McNamara's directive finally made clear that the space program already had to be the catalyst for revolutionary organizational change. Until then, ARDC's Ballistic Missile Division (AFBMD) and AMC's Ballistic Missile Center (AFBMC) had displayed sharp disagreement over responsibilities and intense competition for personnel and resources. Those disputes had prompted General Schriever to inform the Air Force chief of staff of the serious threat he believed such bickering posed to both the ballistic missile program and the infant space program. With General White's approval, Schriever had set out to formulate an Air Force space mission and propose a reorganized R&D structure to handle that mission. On October 4, 1960, he had established a 30-member Space Study Committee, chaired by Trevor Gardner, to project Air Force space development objectives for the next decade from both technical and managerial perspectives. Among the Gardner Committee's sweeping recommendations, published on March 12, 1961, just six days after McNamara's directive, were reorganization of the Air Force to reflect preeminence of the space mission and designation of the new Systems Command as the "clearing house" for release of space information to the public.[33]

During the remainder of the 1960s and 1970s, nearly all resources and organizations associated with Air Force space launch and satellite control shifted incrementally to Space Systems Division, under Systems Command. First the Atlantic and Pacific launch facilities and ranges were reorganized, then the Satellite Control Facility. On April 22, 1967, the Secretary of the Air Force decided to recombine SSD and BMD into the Space and Missile Systems Organization (SAMSO), essentially reconstructing the organization that had existed in early 1961. This move had been studied since 1964, based on arguments about ICBM maturation and deployment, drainage of military space funds for NASA, and inefficient, duplicative management overhead in the two organizations. Activation of SAMSO occurred July 1, 1967, and it continued until a October 1, 1979, split into Space Division and the Ballistic Missile Office, which responded to growth in major space vehicle programs (especially the Space Shuttle) and the M–X missile program. By default, Space Division also continued the operational roles of space launch and satellite control.[34]

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[32] Alice C. Cole, Alfred Goldberg, Samuel A. Tucker, and Rudolph A. Winnacker, eds., *The Department of Defense: Documents on Establishment and Organization, 1944-1978* (Washington, DC: Office of the Secretary of Defense/Historical Office, 1978), p. 325; Neufeld, *Ballistic Missiles*, p. 221; HQ SD/HO, "Space and Missile Systems Organization: A Chronology, 1954-1979," n.d., pp. 4-5, Air Force Space Command History Office.

[33] Gorn, "Vulcan's Forge," pp. 61-63, 67-71; Bernard J. Termena, Layne B. Peiffer, and H.P. Carlin, *Logistics: An Illustrated History of AFLC and Its Antecedents, 1921-1981* (Wright-Patterson AFB, Ohio: HQ AFLC/HO, n.d.), pp. 151-52; McDougall, . . . *the Heavens and the Earth*, p. 339.

[34] Maj. John B. Hungerford, Jr., "Organization for Military Space: A Historical Perspective," Student Report (Air Command and Staff College, Air University, Maxwell AFB, Alabama), March 1982, pp. 39-55; Robert Kipp, HQ AFSPACECOM/HO, "Trends in Military Space: Organizational Growth and Maturity," May 30-31, 1990, pp. 5-6; HQ SD/HO, "Space and Missile Systems Organization: A Chronology, 1954-1979," n.d., passim; J. Catherene Wilman, HQ SD/HO, "Space Division: A Chronology, 1980-1984," n.d., pp. 1-2, all available in Air Force Space Command History Office.

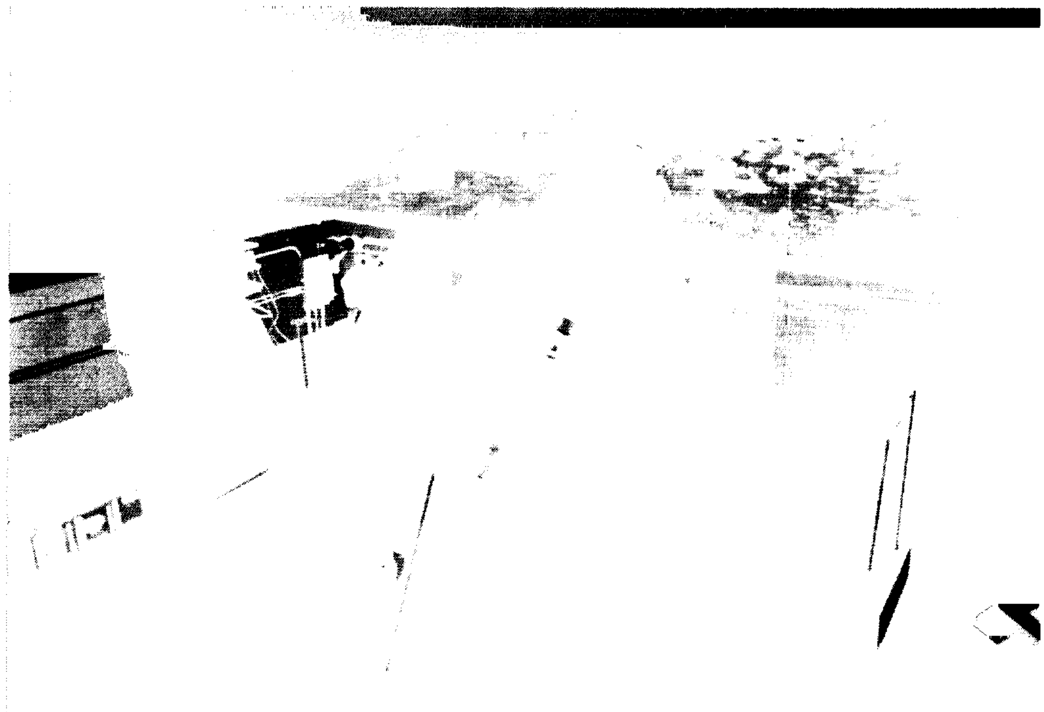

Figure 7 Baker-Nunn cameras were an essential element in the Air Force's early SPACETRACK network. This site at Edwards Air Force Base, California, became operational in December 1960. Photograph from USAF collections.

Even as the Air Force acquisition organization for space became better defined during the 1960s and 1970s, a second major organization (relying almost exclusively on ground-based systems) evolved to handle the operational missions of space surveillance and space defense. With the first Sputnik launch on October 4, 1957, satellite tracking and surveillance had become a military requirement. ARDC had established the first space surveillance center at Hanscom Field, Massachusetts, on November 30, 1957 to receive, process, and catalog data. Early responsibility had been diffused among ARDC, the Navy, and ARPA. Not until October 7, 1960, did Defense Secretary Gates assign operational command of all space surveillance to Continental Air Defense Command (CONAD) and operational control to North American Air Defense Command (NORAD). Technical control of SPACETRACK, the Air Force portion of the surveillance network, went to Air Defense Command (ADC); the Navy kept technical control of its portion, NAVSPASUR. Not until it shifted from Hanscom to Ent Air Force Base, Colorado, on July 12, 1961, did Air Defense Command assume full technical responsibility

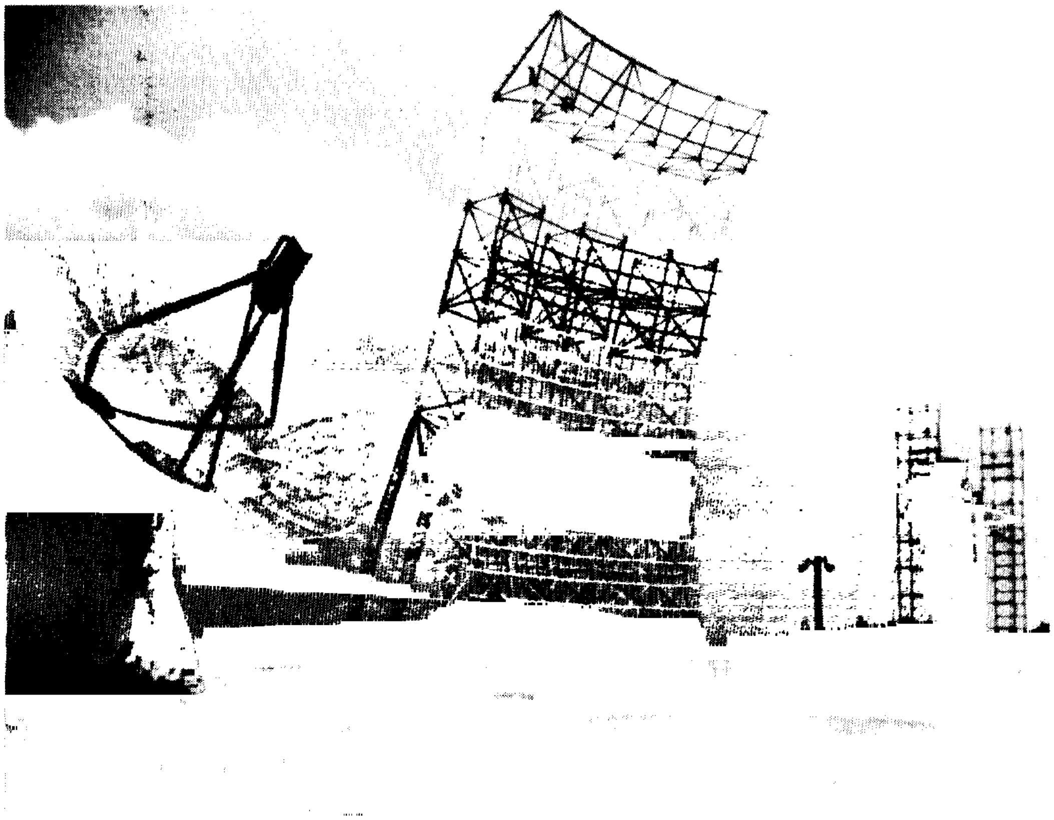

Figure 8 After October 1960, Air Defense Command exercised technical control of SPACETRACK radars. The FPS-78 (right) and FPS-17 (left) at Laredo Air Force Station, Texas, became part of the SPACETRACK network in 1961. Photograph from USAF collections.

for the space surveillance center—i.e., Space Detection and Tracking System (SPADATS)—operations.[35]

The concentration and subsequent dispersal of ADC's operational space missions over the course of almost twenty years began on July 19, 1961, with activation of the 9th Aerospace Defense Division to handle SPADATS, the Ballistic Missile Early Warning System (BMEWS), and the Missile Defense Alarm System (MIDAS). In April 1963, General LeMay warned that the United States ought to think about a strategic space

[35] Robert Kipp, HQ AFSPACECOM/HO, "ADCOM Space Organization, 1961-79," March 8, 1988. Air Force Chief of Staff General Thomas White's assignment of full technical responsibility for the space surveillance center to ADC touched off a long-term controversy over center manning and operational responsibilities between ADC and NORAD that was never satisfactorily resolved and, indeed, became a matter of contention between AFSPACECOM and USSPACECOM in the 1980s and 1990s. For details, see Thomas Fuller, "NORAD and Space Surveillance," December 31, 1986. All available in Air Force Space Command History Office.

force, even if the time was not yet right, because a "military capability for defense is the product not only of technology, but also of training and operational experience."[36] Not surprisingly, therefore, ADC gained an antisatellite (ASAT) mission on November 15, 1963, with activation of the 10th Aerospace Defense Squadron, which until its inactivation in November 1979 was the first and only Air Force space launch organization composed entirely of military or "blue-suit" personnel. That squadron also handled the Defense Meteorological Satellite Program (DMSP) launches during 1967-1979 using Thor boosters.[37] As Air Defense Command broadened to handle more missions, it was redesignated Aerospace Defense Command (still ADC, later ADCOM) on January 15, 1968.[38] The growth and concentration of missions culminated on July 1, 1968, with formation of the 14th Aerospace Force, which had separate wings for space surveillance and missile warning. From that point, reduction in the air defense mission began to leave ADC with a top-heavy management structure. Under prevailing Air Force policy, which defined space operationally as a medium rather than a mission, there was little to prevent ADC's piecemeal disintegration.[39]

A Time of Transition

Several Air Staff studies during the early 1970s proposed elimination of ADCOM to streamline overall major command (MAJCOM) structure and save money. Struggling to survive, ADCOM sought greater efficiency through reversion to a decentralized management scheme; on October 1, 1976, it inactivated the 14th Aerospace Force and dispersed authority to the air divisions. Despite this initiative, the threat remained; budgetary constraints forced progressive reductions in the Air Force's size. In early 1977, an internal Air Staff report—i.e., the Creedon study—became the basis for a more extensive review known familiarly as the "Green Book study" or, more formally, as the "Proposal for a Reorganization of USAF Air Defense and Space Surveillance/Warning Resources." General Daniel "Chappie" James, ADCOM commander, unequivocally opposed implementation of the "Green Book" proposal that called for elimination of ADC as a major Air Force command. When General James E. Hill replaced General James in December 1977, he too opposed the reorganization and, on the eve of retiring in 1979,

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[36] Futrell, *Ideas, Concepts, Doctrine*, 2:227.

[37] Richard Eckert, HQ AFSPACECOM/HO, "Transfer of DMSP Launch Operations to AFSC," February 26, 1990, Air Force Space Command History Office.

[38] On July 1, 1975, JCS reorganized the Aerospace Defense Command into a specified command. Designated by the acronym ADCOM; it retained its identity as a USAF component and simultaneously assumed the functions formerly exercised by Continental Air Defense Command (CONAD). See HQ AFSPACECOM/HO, "Aerospace Defense: A Chronology of Key Events, 1945-90," October 1, 1991, p. 46, Air Force Space Command History Office.

[39] Robert Kipp, HQ AFSPACECOM/HO, "ADCOM Space Organization 1961-79," March 8, 1988, Air Force Space Command History Office; Futrell, *Ideas, Concepts, Doctrine*, 2:684.

told Chief of Staff General Lew Allen, Jr., that ADCOM should retain its space assets as the nucleus for a new space command. Nonetheless, Air Staff proceeded to dismantle ADCOM by transferring its air defense resources to Tactical Air Command (TAC) on October 1, 1979 and its missile warning and space surveillance resources to Strategic Air Command (SAC) on December 1, 1979. Formal disestablishment of ADCOM as an Air Force MAJCOM followed on March 31, 1980. Meanwhile, on December 1, 1979, an Aerospace Defense Center had been activated to train and equip people to support NORAD (whose space surveillance responsibilities remained unchanged) and the specified ADCOM. At that point, the only consolation for Air Force Under Secretary Hans Mark and others who had opposed ADCOM's breakup seemed to be the possibility that Air Force leaders might someday choose to use the residual Aerospace Defense Center organization in Colorado Springs as the core for a new space command.[40]

Although the ADCOM reorganization appeared to be a major setback for proponents of an Air Force operational space command, several trends were converging to provide new grist for their mill. First, during the mid-1960s through the 1970s, military space systems evolved from experimental to operational status. At the same time, communications technology significantly enhanced the tactical utility of those systems by allowing direct transmission of data from satellites to field commanders. For example, through terminals in Saigon and aboard Navy carriers off the coast of Vietnam, the Defense Meteorological Satellite Program had provided essential data for planning air strikes in Southeast Asia. An even more sophisticated use of satellite capabilities was envisioned in July 1967 by Project Compass Link, which provided transmission of high-resolution photographic images between Saigon and Washington, D.C., via the Initial Defense Satellite Communications System (IDSCS) for near-real-time evaluation of battlefield intelligence thousands of miles from the actual site of operations.[41]

Furthermore, space operations became a more significant part of the Air Force budget as the U.S. responded to increased Soviet activity in that arena. Consequently, the debate over whether the Air Force should continue assigning operational space systems functionally on a case-by-case basis, or should centralize operational control of all its space assets under one command, became more heated. Dispersal of systems across the service certainly made it more difficult to coordinate requirements and concepts of operation from a total force perspective. Furthermore, as space systems became more complex with multiple capabilities, delineation of their functional assignment became more difficult. Nowhere was this clearer than with the planned Space Shuttle, where

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[40] Robert Kipp, HQ AFSPACECOM/HO, "The Reorganization of 1979 and the Space Organization Issue," March 8, 1988, U.S. Space Command History Office; Futrell, *Ideas, Concepts, Doctrine*, 2:689; Hans Mark, NASA Dep Admin, to Gen. James V. Hartinger, CINCNORAD, June 22, 1982, w/Encl: Memo by Hans Mark to John Stetson, AF Sec, "Reorganization of NORAD/ADCOM," August 7, 1978, Air Force Space Command History Office.

[41] Brfg, [AFSPACECOM/HO], "Aerospace Defense Organizations in Colorado Springs, 1951-1986," May 10, 1988; Interview Transcript, Maj. Gen. Thomas S. Moorman, Jr., by Robert Kipp and Thomas Fuller, July 27, 1988, 2, both available in Air Force Space Command History Office; Lt. Col. John J. Lane, Jr., *Command and Control and Communications Structures in Southeast Asia* (Maxwell AFB, AL: Air University, 1981), pp. 113-14.

SAC, ADCOM, Air Force Systems Command (AFSC), and Military Airlift Command (MAC) each promoted itself as the Air Force's logical choice to share operational responsibilities with NASA. This led one outspoken critic, who bemoaned this "amalgam of [space] systems and users," to urge in early 1977 that the Air Force create a "separate space command" that "could well develop into a space force" as future requirements grew.[42]

Various studies and pronouncements during the late 1970s pointed to the need for a fundamental change in organizational perspective. The 1975 "New Horizons" study and the 1977 "Future Air Force Space Policy and Objectives" study both blamed inefficient utilization of space assets on inadequate understanding of capabilities and lack of clearly articulated Air Force goals for the operational use of space. Additional impetus for better organizational definition of the Air Force role in space operations came from the May 11, 1978, Presidential Directive No. 37, which asserted the nation's right to free passage and unhampered operation of its property in space and, consequently, its right to defend that property against hostile threats.

The Creation of USAF Space Command

In that particular milieu, numerous individuals foresaw a phoenix rising from the space assets and expertise of the ill-fated ADCOM. Speaking at an Air Force Academy Space Seminar in August 1978, Major General Hoyt S. Vandenberg, Jr., Air Force Deputy Chief of Staff for Operations, urged adoption of a more operational perspective on space systems and "perhaps a space command." Also, during summer 1978, Lieutenant Colonel Charles H. MacGregor and Major Lee H. Livingston, both Air Force officers lecturing on space at Air University (Maxwell AFB, Alabama), charged that most of their fellow officers exhibited a "professional parochialism" favoring airplanes and relegating military space programs to the realm of "flashy gadgetry." Bemoaning the absence of a single Air Force organization with primary space responsibilities, they believed only ADCOM possessed sufficient familiarity with space systems to provide substantive requirements for future operational capabilities. They advocated using ADCOM's space resources as the core for a separate space command, with which other operating commands could work to formulate requirements and shape space doctrine.[43] Echoing that sentiment during an October 1978 Air Force Association Symposium, ADCOM commander General James E. Hill suggested the urgent need for a single point to deal with U.S. military space matters.

Meanwhile, on September 11, 1978, Air Force Secretary John Stetson, at Under Secretary Hans Mark's urging, had authorized a "Space Missions Organizational Planning Study" (SMOPS) to explore options for the future. When the published version

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[42] Col. Morgan W. Sanborn, "National Military Space Doctrine," *Air University Review*, January-February 1977, pp. 76-78; Interview Transcript, Moorman, p. 2.

[43] Lt. Col. Charles H. MacGregor and Maj. Lee H. Livingston, "Air Force Objectives in Space," *Air University Review*, July-August 1978, pp. 60-62.

appeared in February 1979, it offered five alternatives ranging from continuation of the status quo to creation of an Air Force command for space. It revealed a consensus within the Air Force to seek actively a designation as the Defense Department's executive agent for space and to improve the Air Force's organizational structure for conducting space operations, but it also found a distinct lack of consensus on timing and direction.[44]

Despite disagreement about the overall timing and direction of organizational change, the SMOPS study did foster several small steps to clarify managerial differences between development and operation of space systems. On September 1, 1980, AFSC's Space Division created the position of Deputy Commander for Space Operations. Twelve months later, Air Force headquarters established a Directorate of Space Operations within its DCS/Plans and Operations. Earlier, the Air Force Scientific Advisory Board's 1980 "Summer Study on Space" had concluded that, although the service had done well during the preceding fifteen years turning experimental systems into reliable, operational ones, the Air Force was inadequately organized for operational exploitation of space and placed insufficient emphasis on the inclusion of space systems as essential elements in an integrated force structure.[45]

That seemed true despite the February 14, 1979, publication of Air Force Manual 1-1, *Functions and Basic Doctrine of the United States Air Force*, which for the first time officially identified space operations as one of the Air Force's nine basic operational missions. According to the manual, "The Air Force mission in space [was] to conduct three types of space operations: space support; force enhancement; and space defense."[46] Although the concept of space as "operating medium" rather than "operational mission" would prevail throughout the 1980s and early 1990s, Air Force leaders henceforth would remember that in those "outer reaches" of their "multidimensional operating environment" the Air Force had a definite mission—one for which it seemed preeminently qualified among all the services.[47] That perception would lead Chief of Staff General Merrill A. McPeak to observe as recently as 1992 that the Air Force mission was "to defend the United States through control and exploitation of air and space."[48]

The divergence of opinions at both the early 1981 Air University Airpower Symposium and the April 1-3, 1981, Air Force Academy Space Doctrine Symposium revealed continuing contentiousness among senior Air Force leaders on how best to

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44 Futrell, *Ideas, Concepts, Doctrine*, 2:689-90; Interview Transcript, Moorman, pp. 3-5.

45 Futrell, *Ideas, Concepts, Doctrine*, 2:691; Wilman, "Space Division: A Chronology," pp. 44, 58.

46 AFM 1-1, *Functions and Basic Doctrine of the United States Air Force*, February 14, 1979, 2-6; Futrell, *Ideas, Concepts, Doctrine*, 2:690.

47 AFM 1-1, *Basic Aerospace Doctrine of the United States Air Force*, March 16, 1984, p. 2-2. For examples of how Air Force leaders have defined space, see HQ AFSPACECOM/HO, "Defining Space," n.d., available in Air Force Space Command History Office.

48 Gen. Merrill A. McPeak, USAF Chief of Staff, "The Air Force Role in Space," *Space Times* 32 (July-August 1993): 6.

achieve more centralized management of space operations. During the Academy sessions, Space Division Commander Lieutenant General Richard C. Henry emphasized that the extraordinary, highly technical nature of spacecraft construction and orbital support made it very difficult to separate acquisition from operations. While not necessarily disagreeing with Henry, a number of primarily younger officers, nonetheless, presented papers advocating either evolution toward, or immediate creation of, a new Air Force major command for space operations.[49]

Added impetus for making a decision sooner rather than later came from outside the military. Testifying before the Senate Armed Services Committee in November 1981, Air Force Under Secretary Edward C. Aldridge, Jr., acknowledged the need for a more coordinated, integrated approach to military space operations and pointed to establishment of "some form of a 'space command'" by the Air Force as the right answer.[50] In the House of Representatives, Colorado's Ken Kramer introduced a bill on December 8, 1981, requiring the Air Force to report on the desirability of creating a space command and renaming the service itself the "United States Aerospace Force." Air Force Secretary Verne Orr and Chief of Staff Lew Allen opposed the name change but obligingly acknowledged they were seriously considering a new command.[51] If they needed further reason to entertain that idea, a General Accounting Office (GAO) report in January 1982 criticized the entire Defense Department for poor management of space systems and recommended designation of a single manager for military exploitation of space. Identifying the Air Force's planned Consolidated Space Operations Center (CSOC) as the potential "nucleus for a future space force" or a "future space command," the GAO recommended that Congress withhold CSOC funding until the Defense Department came up with an overall plan for the military exploitation of space.[52] In the face of these outside pressures, it was increasingly obvious that the Air Force could maintain control of the process (which Under Secretary Aldridge wanted to do at all costs) only by developing a substantive plan for the evolution of an Air Force operational space organization.

Meanwhile, during August 1981, NORAD/ADCOM Commander in Chief General James V. Hartinger had met privately at Andrews Air Force Base, Maryland, with his

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[49] Speech by Lt. Gen. Henry in Maj. Paul Viotti, ed., *Military Space Doctrine—The Great Frontier: The Final Report for the USAFA Military Space Doctrine Symposium*, 1-3 April 1981. For papers presented during the symposium, see Maj. Peter A. Swan, comp., *Military Space Doctrine—The Great Frontier: A Book of Readings for the USAFA Military Space Doctrine Symposium*, 1-3 April 1981, 4 vols. For a concise summary of the symposium's findings, see Futrell, *Ideas, Concepts, Doctrine*, 2:691-92.

[50] Thomas Karas, *The New High Ground: Strategies and Weapons of Space-Age War* (New York: Simon & Schuster, 1983), 18; Futrell, *Ideas, Concepts, Doctrine*, 2:695.

[51] Ken Kramer (R-CO), "The Space Challenge—Can We Meet It?" *Military Electronics/Countermeasures*, November 1981; "Military Force in Space?" *Gazette Telegraph* (Colorado Springs, CO), December 5, 1981; Verne Orr to Ken Kramer, "[Proposals Regarding USAF]," December 11, 1981; Ken Kramer to Melvin Price, "[Organizational Problems Affecting U.S. Military Space Program]," February 2, 1982, Air Force Space Command History Office.

[52] Karas, *New High Ground*, p. 19.

Figure 9 An Aerospace Defense Command planning team helped prepare the April 1982 briefing to the Air Staff on organizational options for space. The team consisted of (left to right): Brig. Gen. Carl N. Beer, DCS/Plans; Col. Richard P. MacLeod, Chief of Staff; Maj. Gen. Bruce K. Brown, Assistant Vice Commander; Gen. James V. Hartinger, Commander in Chief (holding a slide that proposed a separate operational space command); Lt. Col. Sam Beamer, Chief of Plans and Policy Division; Col. Thomas S. Moorman, Jr., Director of Commander's Group; and Col. G. Wesley Clark, Director of Space. Photograph from USAF collections.

longtime friend General Robert T. Marsh, Air Force Systems Command (AFSC) commander. They had agreed to raise the issue of an operational space command at the February 1982 "Corona" meeting of senior Air Force leaders at Homestead Air Force Base, Florida. When that time came, all eight closed-door executive sessions were monopolized by discussion of their skeletal proposal. Finally, on the last day of the "Corona" conference, during the last five minutes of the last executive session, Chief of Staff General Lew Allen directed Hartinger and Marsh to prepare a detailed briefing by mid-April on how to move toward an operational command for space.[53]

[53] Videotaped Interview, Gen. James V. Hartinger (USAF, Ret) by Rick W. Sturdevant, HQ AFSPACECOM/HO, August 20, 1992; Robert Kipp, HQ AFSPACECOM/HO, "Background to Formation of Air Force Space Command," February 11, 1987, w/Atch, both in Air Force Space Command History Office.

Hartinger's and Marsh's staffs both formed working groups to develop the Air Staff briefing. Although the groups met periodically to review each other's work, they did not exactly find common ground. Taking into account the fragmented management of Air Force space activities among twenty-six different organizations, the absence of an operational advocate for space systems, and the lack of provisions for using space systems in wartime, Hartinger's staff pushed vigorously for immediate, revolutionary action to create a separate, new command. Marsh's staff, on the other hand, favored a slower, more evolutionary approach. When Lieutenant General Jerome F. O'Malley, Air Force Deputy Chief of Staff for Plans and Operations, stopped briefly at the Chidlaw Building in Colorado Springs on April 15, Hartinger's staff showed him an extra briefing chart they had prepared to depict how a space command might be formed at once. Liking what he saw, O'Malley suggested that Hartinger bring the chart with him to Washington.[54]

The all-important briefing to Air Staff finally occurred on April 17, 1982. After hearing System Command's formal presentation on the "Space Organizational Issue," General O'Malley objected to its vagueness on when an operational space command might be formed. General Hartinger then revealed his more specific slide showing how the Air Force might immediately create a major command for managing space resources on a par with Strategic Air Command (SAC), Tactical Air Command (TAC), and Military Airlift Command (MAC). His proposal quickly won General Allen's blessing and, subsequently, went to Air Staff's Space Operations Steering Committee for further refinement. On June 21, the Air Force officially announced its decision to form Air Force Space Command effective September 1, 1982.[55]

In making that announcement, Undersecretary Aldridge predicted that from its "embryonic structure" the new command would "develop and expand its role and responsibilities" as it matured and as space missions evolved. Initially, Space Command's mission included managing and operating assigned space assets, centralizing plans, consolidating requirements, providing operational advocacy, and ensuring a close interface between R&D activities and operational users of Air Force space assets. As first commander of Space Command, General Hartinger also remained NORAD and ADCOM commander in chief (CINC).[56] To help allay any problems in transitioning systems from the R&D realm to the fully operational, the commander of AFSC's Space Division was assigned additional duty as Space Command's deputy commander.

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[54] Videotaped Interview, Hartinger, August 20, 1992; Interview Transcript, Moorman, pp. 15-18.

[55] Memo by E.C. Aldridge, Jr., to USAF Chief of Staff, "Establishment of Space Command—ACTION MEMORANDUM," June 21, 1982; News Release, Asst Sec Def, "U.S. Air Force to Form Space Command," June 21, 1982; Interview Transcript, Moorman, pp. 18-20, both in Air Force Space Command History Office.

[56] The triple-hatting arrangement of CINCAD/CINCNORAD/MAJCOM commander briefly became a quadruple-hatting arrangement with establishment of USSPACECOM in September 1985 under General Robert Herres' leadership. On October 1, 1986, however, Herres relinquished command of AFSPACECOM to Major General Maurice C. Padden. With disestablishment of ADCOM as a specified command on December 19, 1986, only a USCINCSPACE/CINCNORAD dual-hat arrangement existed. Robert Kipp, HQ AFSPACECOM/HO, "[Untitled Paper]," October 4, 1989, Air Force Space Command History Office.

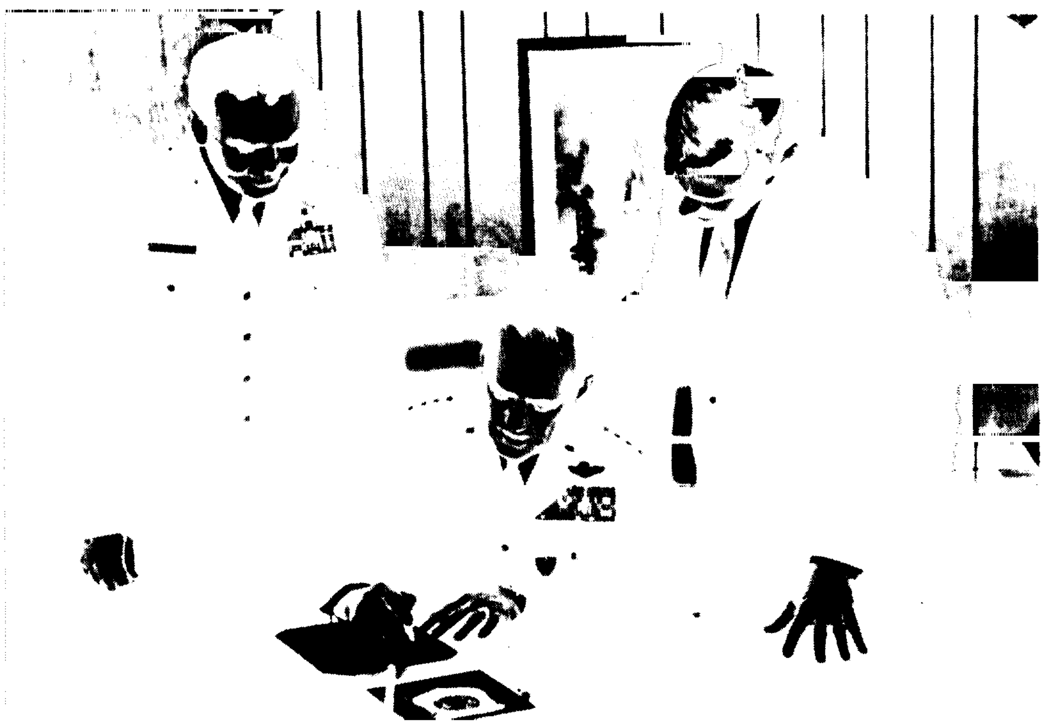

Figure 10 With Air Force Vice Chief of Staff Gen. Jerome F. O'Malley and Air Force Under Secretary Edward C. Aldridge, Jr., observing, Gen. James V. Hartinger signed Special Order GD-1 on September 1, 1982, to become USAF Space Command's first commander. Photograph from USAF collections.

Not stopping with creation of Space Command, the Air Force also established an Air Force Space Technology Center at Kirtland Air Force Base, New Mexico, subordinate to Space Division. The Space Technology Center would focus on basic technology, while Space Division itself would concentrate on the more mundane aspects of R&D, launch, and checkout. Space Command would assume on-orbit control, management, and protection responsibilities for systems.[57]

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[57] Gorn, "Vulcan's Forge," p. 102; Stares, *Militarization of Space*, pp. 219-20; Robert Kipp, HQ AFSPACECOM/HO, "Formation of Space Command," March 8, 1988. In Fiscal Year 1984 budget hearings before the Senate Armed Services Committee, Major General Bruce K. Brown, vice CINCNORAD/assistant vice commander, Space Command, pointed to the convergence of several factors in 1982 that allowed formation of SPACECMD: "the Soviet threat in space, our Nation's increasing dependence on space systems, an ever increasing national space resource commitment, and the need to take full advantage of the space shuttle to enhance man's presence in space." Pointing to President Reagan's July 4, 1982, announcement that the most important goal of the U.S. space program was to strengthen national security, General Brown added that the U.S. finally had "a policy which underscores the need to move Air Force space programs out of the research and development community into the operational world." Futrell, *Ideas, Concepts, Doctrine*, 2:697-98.

Figure 11 Construction of the Consolidated Space Operations Center at Falcon Air Force Station, Colorado, began May 1983. Photograph from USAF collections.

Despite Space Command's relatively broad charter, bringing the various Air Force "operational" space activities under its control proved to be a lengthy, challenging ordeal. Other large organizations within the Air Force had a vested interest in retaining various "operational" space responsibilities for as long as possible. Systems Command, in particular, dragged its feet with respect to handing over satellite control and space launch responsibilities. Despite such resistance, SAC gave Space Command operational responsibility for a worldwide network of more than twenty-five space and missile warning sensors in 1983. Furthermore, Space Command became operational manager for the Defense Meteorological Satellite Program, the Satellite Early Warning System, and the planned Milstar system. Construction began on the Consolidated Space Operations Center (CSOC) at Falcon Air Force Station, Colorado, in May 1983. The following month space shuttle contingency support operations transferred from Systems Command to Space Command. On January 1, 1984, Space Command assumed resource management responsibility for the NAVSTAR Global Positioning System (GPS), with full operational control following on January 16, 1986. The Satellite Control Facility at Onizuka Air Force Base, California, along with a worldwide network of remote tracking stations, finally became Air Force Space Command's on October 1, 1987. Exactly three years later, on October 1, 1990, Air Force Space Command assumed the space launch

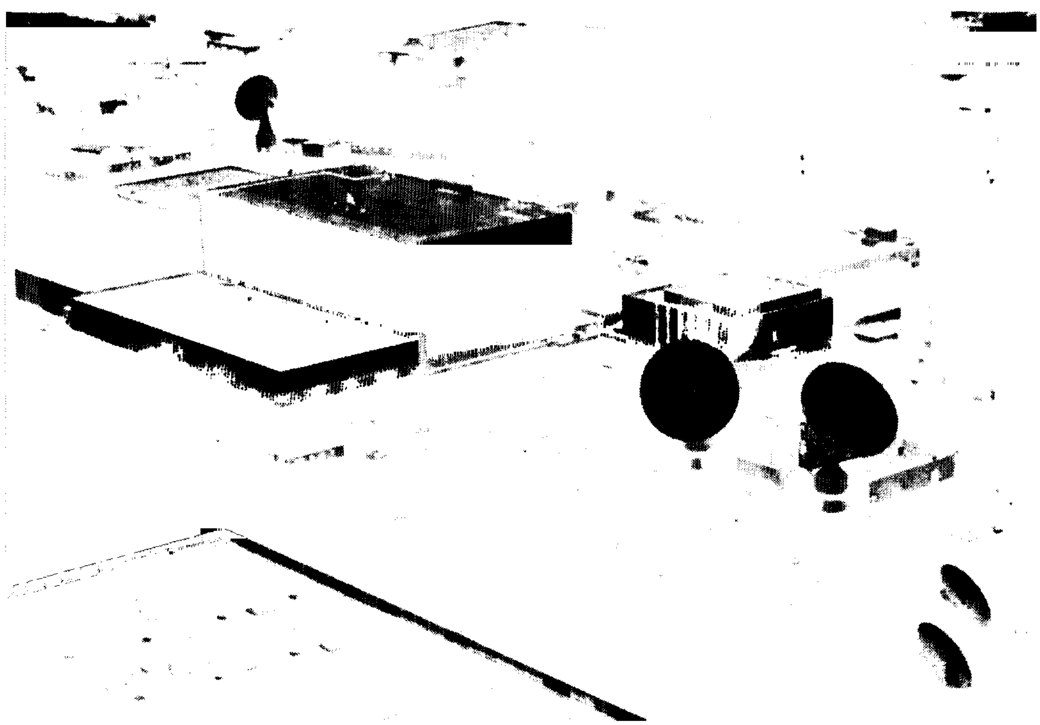

Figure 12 The Satellite Control Facility at Onizuka Air Force Base, California, transferred from Air Force Systems Command to Air Force Space Command on October 1, 1987. Photograph from USAF collections.

mission from Systems Command. In 1991 Space Command gained administrative responsibility for all USAF astronauts.[58]

The Air Force had never perceived establishment of its Space Command as an end unto itself but, rather, as a fundamental step toward the broader goal of a unified command for space operations.[59] It simply had made little sense to create a unified entity

[58] Lt. Col. John C. Tait and Lt. Col. Robert E. Larned, "Space Command: The Air Force's Ugly Duckling?" Research Paper (Washington, DC: Industrial College of the Armed Forces, National Defense University), June 1983, p. 23; Maj. Mason H. Beckett, Jr., "The United States Air Force: Organizing for Space Operations, 1957-1985," Student Report (Maxwell AFB, AL: Air Command and Staff College, Air University), April 1986, pp. 43-46; HQ AFSPACECOM/HO, "Aerospace Defense: A Chronology of Key Events, 1945-1990," passim.

[59] According to Craig Covault, "USAF Studies Space Command," *Aviation Week and Space Technology*, October 23, 1978, pp. 14-16, some USAF officers already believed that once an Air Force Space Command was formed, a U.S. Space Command would follow to unify USAF, Army, and Navy space efforts. Citing Air Force Under Secretary Hans Mark, Covault explained that introduction of the space shuttle as the first new launch vehicle in thirty years was the most important factor compelling the Air Force to restructure for better management of space systems.

without first creating component service commands. Because Air Force leaders believed their service was rapidly achieving the same sort of preeminence in military space operations that it earlier had achieved in space systems acquisition, the timing seemed right for the Air Force to promote a unified command through which it could lead coordination of all U.S. military space operations. Several months before President Ronald Reagan's March 23, 1983, speech proposing a Strategic Defense Initiative (SDI) and thereby giving new emphasis to the vital role of space systems in national defense, Air Force Space Command planners had briefed General Hartinger on alternative proposals for a unified space command. On April 18, 1983, Hartinger responded to a Joint Chiefs of Staff (JCS) call for organizational changes to accommodate Reagan's SDI proposal by suggesting that creation of a unified space command seemed logical. Air Force Chief of Staff General Charles A. Gabriel threw his active support behind that idea on June 7, 1983.[60]

Prospects became still brighter with activation of a Naval Space Command on October 1, 1983, even though the Navy itself generally opposed creation of a unified space command. Air Force Secretary Orr and General Gabriel issued a joint statement early in 1984 in which they strongly recommended a unified command for space, because "no single military organization exercises operational authority over military space systems in peace, war, and the transition period from peace to war."[61] In support of their position, General Bernard Randolph, Air Staff Director of Space Systems and C3, argued that it was "very difficult to say that a space system was an Air Force, Navy, or Army system because . . . the way they work . . . in the main is in fact jointly." Considering the expense of fielding and maintaining space systems, Randolph did not believe the country could afford multiple military organizations in space.[62] Such high-level Air Force advocacy prevailed over the Navy's reluctance, and the Defense Department accepted a unified space command with Air Force, Navy, Army, and Marine Corps participation as "the next evolutionary step" toward centralization of "operational responsibilities for more effective use of military space systems."[63] On November 20, 1984, the President approved formation of a U.S. Space Command (USSPACECOM). Reagan approved JCS recommendations for the new command's mission assignments and organization on August 30, 1985, and USSPACECOM was formally activated at Peterson Air Force Base, Colorado, on September 23, 1985.[64]

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[60] Interview Transcript, Moorman, pp. 29-37; HQ AFSPACECOM/HO, "Formation of US Space Command," August 1987, pp. 1-2.

[61] Futrell, *Ideas, Concepts, Doctrine*, 2:698-99.

[62] *Ibid.*, 2:699.

[63] *Ibid.*, 2:699-700.

[64] Brfg, [HQ AFSPACECOM/HO], "Aerospace Defense Organizations in Colorado Springs, 1951-1986," May 10, 1988; Thomas Fuller, USSPACECOM/HO, "Formation of US Space Command," July 2, 1986, both in Air Force Space Command History Office. A detailed survey of processes leading to establishment of USSPACECOM is James C. Gaston's forthcoming, *Origins of the US Space Command* (Washington, DC: National Defense University Press).

Events since then have left many wondering what organizational changes might come next and whether there is any truth to the adage that history repeats itself. On the acquisition side, funding cuts and procurement scandals led to an Air Force retrenchment in which Logistics Command and Systems Command merged to form a single Air Force Materiel Command like that of the 1940s, with Space Division regaining missile R&D responsibilities and becoming Space and Missile Systems Center. This happened despite admonitions from General Schriever and other early leaders of the Air Force space R&D effort to renew the revolutionary, radical approach in order to acquire new launch capabilities and satellite systems.[65] On the operational side, responsibilities and lines of authority between AFSPACECOM and USSPACECOM proved confusing due to the nature of space assets and of the organizations themselves. Many people, both inside and outside the Air Force, found it difficult to understand AFSPACECOM's roles as a major command and a unified component. The Defense Department's Inspector General found no need for component commands to support USSPACECOM, but Air Force leaders believed AFSPACECOM should take over many, if not all, of the unified command's responsibilities. When the USSPACECOM and NORAD commander in chief once again became "triple-hatted" as AFSPACECOM commander on March 23, 1992, it was *déjà vu* to many.

Speculation grew that the Air Force soon might gain broader responsibility for the nation's military space activities. In a February 12, 1993, report on "Roles, Missions and Functions of the Armed Forces of the United States," JCS chairman General Colin Powell recommended that the Air Force alone be given management of all Defense Department space acquisitions and operations.[66] Seizing Powell's argument that it would reduce long-term costs and achieve operational efficiencies, senior Air Force leaders quickly proclaimed their readiness to accept the increased responsibility.[67] During a keynote speech at the Ninth National Space Symposium in Colorado Springs on April 15, 1993, General McPeak, Air Force chief of staff, publicly asserted that "all our military space business—acquisition and operations—should be consolidated in the Air Force." To dampen the resistance of Army and Navy opponents, McPeak referred approvingly to AFSPACECOM's recent moves to establish a "Space Applications and

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[65] Neufeld, *Reflections*, p. 84.

[66] William Matthews and Julie Bird, "Powell Calls For Consolidation, But No Major Overhaul," *Air Force Times*, February 22, 1993, p. 4.

[67] Lt. Gen. Thomas S. Moorman, Jr., AFSPACECOM/CV, "The 'Space' Component of 'Aerospace,'" *Comparative Strategy* 12 (1993): 254. As a follow-up to Powell's "Roles and Missions" paper, USCINCSPACE General Charles Horner submitted to JCS a "Space Systems: Roles and Missions Study Group Final Report" at the beginning of February 1994. Contrary to Powell's original statement, the Horner document said the Air Force should not be the sole agent in charge of design, acquisition, and operation of all U.S. military space systems. See Ben Iannotta, "AF's Military Space Role Examined," *Space News*, February 7-13, 1994, p. 3.

Warfare Center" and hoped it might become a joint agency involving people from all the services.[68]

That center, in fact, reflected an operational perspective gained from the Gulf War in early 1991. For the first time, space assets had been used extensively to support air, ground, and sea forces, thereby enhancing their performance on the battlefield. So important was the contribution of space systems that General McPeak called Desert Storm "the first space war."[69] That experience, coupled with the end of the Cold War and significant cuts in SDI funding, caused Air Force leaders to focus less on strategic needs and more on the theater or tactical applications of space resources. Air Force Space Command's principal emphases had been tracking orbital bodies and charting space debris, controlling satellites, and launching space vehicles; now, AFSPACECOM added the challenge of working with other Air Force commands, as well as with the Army, Navy, and Marines, to further integrate the application of space systems into all levels of war planning. Acting on the recommendation of a "Blue Ribbon" panel headed by AFSPACECOM Vice Commander Lieutenant General Thomas S. Moorman, Jr., AFSPACECOM Commander General Charles Horner created the Space Warfare Center (activated November 1, 1993) at Falcon AFB, Colorado. Horner believed such a center would educate warfighters on battlefield application of space assets and help determine the full range of American warfighters' space-based requirements at the dawn of the 21st century.[70] Full support for that endeavor came from Air Force Secretary Sheila E. Widnall, who said in late summer 1993, "First, controlling and exploiting space is essential for successful military operations. . . . General McPeak and I are both committed to improved applications of space to modern warfare—from exercises to mission planning to execution."[71]

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[68] For a condensed version of McPeak's address, see "The Air Force Role in Space," in American Astronautical Society's *Space Times* 32 (July-August 1993): 5-7. For media coverage of the event, see Genevieve Anton, "Air Force Chief Urges Consolidation of All Military Space Operations," *Gazette Telegraph* (Colorado Springs, CO), April 16, 1993.

[69] Moorman, *Comparative Strategy*, pp. 251-55; McPeak, *Space Times*, p. 5. For an assessment of the importance of space systems in the Gulf War, see Sir Peter Anson and Dennis Cummings, "The First Space War: The Contribution of Satellites to the Gulf War," *RUSI Journal*, Winter 1991, pp. 45-53.

[70] Lt. Gen. Thomas S. Moorman, Jr., AFSPACECOM/CV, to HQ USAF/PE, "Establishment of USAF Space Warfare Center," July 2, 1993; Special Order GD-036, HQ AFSPACECOM, October 22, 1993; Program, "Space Warfare Center Activation," December 8, 1993; Genevieve Anton, "Space Warfare Center Brings Resources Together," *Gazette Telegraph*, December 9, 1993, p. B-4.

[71] Office of the Secretary of the Air Force, "Policy Letter," September 1993.

Chapter 8

Developing a Management Structure for the Strategic Defense Initiative

Donald R. Baucom[1]

On March 23, 1983, President Ronald W. Reagan surprised the nation and much of his own administration by announcing the beginning of a major missile defense program that came to be known as the Strategic Defense Initiative or SDI. Within days of this announcement, Reagan issued formal guidance calling for the completion of two major studies that would map out a plan for a long range research and development program to see if it might be possible to develop an effective defense against ballistic missiles. The first of these was the Defense Technology Study, known as the Fletcher report after its chairman, Dr. James C. Fletcher, former NASA Administrator. The second was a study of the strategic ramifications of a national policy that would place greater emphasis on strategic defenses; it was known as the Future Security Strategy Study. Both reports were to be up-dated annually.[2]

From spring until the late summer of 1983, Pentagon work on SDI focused on completing these two major studies, which would then provide the strategic and technical frameworks for the program. But as the studies neared completion, the focus of Pentagon activity naturally began to shift toward issues related to what would have to be

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[1] Donald R. Baucom is the historian for the Ballistic Missile Defense Organization of the Department of Defense in Washington, D.C. He received his Ph.D. in history from the University of Oklahoma in 1976, while on active duty with the U.S. Air Force. He has taught history at the U.S. Air Force Academy and the Air War College, and edited the *Air University Review*. His book, *The Origins of SDI, 1944-1983* (University Press of Kansas, 1992), received the prestigious Richard W. Leopold Prize from the Organization of American Historians.

[2] National Security Decision Directive, March 25, 1983, and National Security Study Directive, April 18, 1983.

Figure 1 Dr. James C. Fletcher had been involved in the space and missile community since the 1950s, serving as head of the guided missile division for the Ramo-Wooldridge Corporation, and overseeing its transformation into Space Technologies Laboratories. He had served as NASA Administrator between 1971 and 1977, and had remained an important participant in the space policy-making process in Washington afterward. Ronald Reagan tapped him to lead his Defense Technology Study. Photograph from NASA collections.

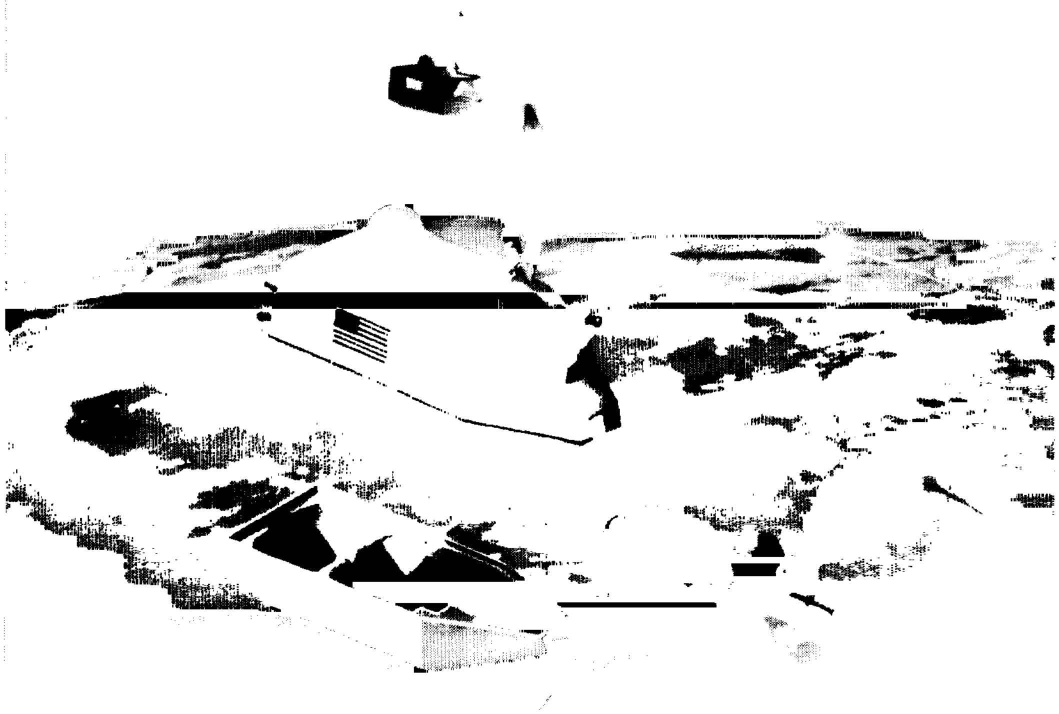

Figure 2 This is an artist's rendering of the Brilliant Pebbles (BP) interceptor concept, which had become the centerpiece of President Reagan's Strategic Defense Initiative (SDI) by 1989. But before SDI could soar into space with systems like BP, the Pentagon had to solve the mundane, bureaucratic problems associated with establishing a management structure to oversee billions of dollars worth of research and development projects. In the foreground of the illustration, a Pebble has shed its protective "life jacket" following receipt of an arming command from the ground. It is now ready to intercept attacking ballistic missiles shown on the right as they rise through the atmosphere. Photograph from USAF collections.

done to implement report recommendations. The foremost of these was how the new program should be managed. The effort to devise a management structure for the SDI program pitted those who favored extraordinary procedures for managing SDI against those who believed that the established bureaucratic structure, with minor modifications, was adequate to the management challenges posed by this program. As one might expect, the management structure that emerged from this struggle was a compromise.

The Manhattan Project as a Model for the SDI Organization

Ronald Reagan came to office in 1981 with strong leanings toward missile defenses. He had been deeply troubled in July 1979 to learn that the United States had no way to counter an attack by Soviet nuclear-tipped missiles. As a result, he directed his campaign staff to prepare a memorandum commenting favorably on the strategic and political promise of missile defenses. Later, the Republican platform for the 1980 presidential campaign stated that Republicans "reject the mutual-assured-destruction (MAD) strategy of the Carter Administration which limits the President during crises to a Hobson's choice between mass mutual suicide and surrender." Furthermore, a plank in the platform called for the "vigorous research and development of an effective anti-ballistic missile system, such as is already at hand in the Soviet Union, as well as more modern ABM technologies."[3]

Campaign papers and platforms notwithstanding, during the early months of his first presidency, Reagan and his administration made America's economic problems their first priority. By late 1981, however, missile defenses were again receiving attention within the White House. One critical episode came in January 1982 when the High Frontier Panel, a group of influential Republicans led by Karl R. Bendetsen, a former assistant and under secretary of the Army, met with President Reagan and recommended that the United States pursue a new crash program aimed at developing missile defenses. The Soviets, the panel believed, were achieving a dangerous advantage in the area of strategic nuclear forces. Furthermore, panel members were convinced that the U.S. could not hope to match Soviet strategic offensive forces even if the nation were placed on a war footing. Moreover, there were "strong indications" that the Soviets were about to deploy "powerful directed energy weapons" in space which would allow them to dominate space and the earth. As a result, the panel urged the President to appoint "an Advisory Systems Selection Task Force" to select defensive systems for development. Once this step was completed, the president should establish a special managerial structure to implement the recommendations of the task force. This structure would be similar to the Manhattan Project that managed America's atomic bomb program. This course of action would allow the U.S. to end its reliance on mutual assured destruction and adopt a doctrine of "assured survival."[4]

Following Bendetsen's presentation, there was a discussion of the special committee and management procedures the panel was recommending. Bendetsen stressed the urgency of America's situation and urged the president to proceed rapidly with the program the High Frontier Panel had advanced. He also emphasized the "indispensability of

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[3] Interview with Martin Anderson, Stanford, CA, August 3, 1987, p. 1; Martin Anderson, Reagan for President Committee, Policy Memorandum Number 3, Foreign Policy and National Security, August 1979, p. 6; National Committee on Resolutions to the Republican National Convention, *Republican Platform: Family, Neighborhood, Work, Peace, Freedom*, Detroit, MI, July 14, 1980, pp. 55-56. For a more accessible account of Reagan's visit to Cheyenne Mountain, see Martin Anderson, *Revolution* (New York: Harcourt Brace Jovanovich, 1988), pp. 80-83.

[4] Karl R. Bendetsen, Memorandum for the President, "Conclusions and Recommendations of the High Frontier Panel," December 18, 1981, in Bendetsen Papers on High Frontier.

Figure 3 An influential private citizen, Karl R. Bendetsen, was a strong advocate of ballistic missile defenses. In the year and a half before Reagan's March 1983 speech, Bendetsen had access to President Reagan and his White House staff and used this access to stump for the establishment of a major missile defense program. After Reagan's speech, Bendetsen continued his advocacy by calling for a crash missile defense program that would be managed as the Manhattan District had managed the U.S. atomic bomb program during World War II. Photograph from SDI Collections.

special management arrangements which would remove from regular channels of the departments and agencies the recommended projects."[5]

Over a year elapsed between the time of Bendetsen's briefing to the president and the March 1983 speech that marked the beginning of the Strategic Defense Initiative. In that time, Bendetsen and his panel continued to importune the White House on behalf of missile defenses, and they continued to do so throughout the formative period from March 1983 until April 1984 when the Strategic Defense Initiative Organization was formally established.[6]

On April 20, 1983, Bendetsen addressed a letter to the principal High Frontier Panel members in which he stated that he had just completed an "intense review of the current situation within the Department of Defense bearing upon The President's decision to establish missile defense systems." Based on this review, he concluded that it was urgent for Panel members to prepare and present to Reagan a "persuasively compelling case for the establishment of special management measures" for the Strategic Defense Initiative.[7]

A memorandum attached to this letter gives an insight into why Bendetsen was so determined to see a special management arrangement established for SDI. The memorandum discusses the possible role of directed energy weapons (DEWs) in missile defense. This discussion was based on an "in-depth comparative analysis" of six DEW technologies that was completed by Schafer Associates for the Defense Advanced Research Projects Agency (DARPA). Schafer organized six panels to complete the study, which addressed the theoretical problem of how best "to interdict a salvo of 1,000 ICBMs." According to Bendetsen,

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[5] Karl R. Bendetsen, "Report to the Members of the High Frontier Project Panel," January 9, 1982, Bendetsen Papers on High Frontier. Determining how well the recommendations of Bendetsen's panel reflect the actual Manhattan Project experience is not a concern of this paper. However, its recommendations do appear to reflect the general philosophy of the Manhattan Project. Without going into great detail, the management of the atomic bomb project was marked by highly centralized control exercised by Major General Leslie R. Groves who had direct access to top government officials such as the Secretary for War and, at least nominally, to the president himself. Groves received general guidance from advisory committees, which included top policy makers and then managed the entire project with an extremely small staff in which he was essentially the only decision maker in the execution of the atomic bomb program. The organizational structure that carried out most of Groves's decisions was actually the Army's Manhattan Engineering District, which was patterned after the engineering district structure developed by the Army Corps of Engineers to handle special projects. Additionally, the project also enjoyed the highest national priority. For details of Manhattan Project management see: Vincent C. Jones, *Manhattan: The Army and the Atomic Bomb* (Washington DC: U.S. Army Center of Military History, 1985), pp. 14-26, 71, 77, 88-91; Leslie R. Groves, *Now It Can Be Told: The Story of the Manhattan Project* (New York: Harper & Brothers, 1962), pp. xii-xiii, 4, 11, 24-25, 28-29, 413-15.

[6] For a discussion of the High Frontier Panel and its activities prior to March 1983, see Donald R. Baucom, *The Origins of SDI: 1944-1983* (Lawrence: University Press of Kansas, 1992), Chapter 7.

[7] Karl R. Bendetsen, Memorandum for Frank Barnett, et. al., April 20, 1983, with a second Memorandum attached, in Bendetsen Papers on the High Frontier Panel.

> the outcome of these analyses indicated that the Neutral Particle Beam possessed the most promising characteristics with Short Wave Length lasers in very close competition. This careful study established that Long Wave Length Directed Energy lasers are unsuitable either for missile defense system or antisatellite applications.[8]

Because of this study, Bendetsen was disturbed to find that the only major DEW program in the Defense Department focused on long-wave lasers. How could this be, given the conclusions of the Schafer study? Bendetsen reasoned that the answer was to be found in the dynamics of the Defense Department bureaucracy: the long-wave laser was the only one of the six laser technologies with a supporting "'constituency.'" This constituency, according to Bendetsen, consisted of "certain key officials in DOD whose characteristics are stubbornness and inertia, plus a very persuasive, able and strong defense contractors' lobby determined to protect their substantial contracts. Time and billions are being wasted."[9] This was the kind of behavior[10] a special organization would overcome.

On May 13, Bendetsen sent to Panel members a copy of a draft memorandum that he proposed to give President Reagan. Here, Bendetsen argued that the new missile defense program had to be managed in accordance with "the lessons learned in the past in Manhattan, etc." He then noted that

> The new technology mix required to attain the posture imperatively required [for missile defenses] is supremely complex. The reallocation of budgets from established traditional programs to new and innovative programs characterized by a large variety of unknowns is exceedingly difficult to accomplish, not only within the existing bureaucracy, but even more so on the Hill.[11]

After numerous drafts of the memorandum for the president, a final version was ready May 23. It stated that the Soviets were out to gain control of space; and if they achieved this goal, it would "alter the world balance of power." The gravity of the situation dictated "the adoption of extraordinary measures." The memorandum described three precedents for the type of management required for the new missile defense program. First, there was the Manhattan Project for developing the atomic bomb. According to Bendetsen:

> In Manhattan, The President appointed a project executive to whom he delegated plenary power and removed the project entirely from the War Department [this is not exactly true] and all bureaucratic channels. He also banned a single choice among

[8] *Ibid.*

[9] *Ibid.*

[10] For a discussion of the dynamics of weapons procurement by military service bureaucracies, see Carl H. Builder, *Masks of War: American Military Styles in Strategy and Analysis* (Baltimore, MD: Johns Hopkins University Press, 1989), pp. 17-43.

[11] Karl R. Bendetsen, Memorandum for Joseph Coors, Jaquelin Hume, Edward Teller, and William Wilson, May 13, 1983, in Bendetsen Papers on the High Frontier Panel.

> unproven technological approaches. The unknowns were at least as great as those we now face. In parallel, three major facilities were built to test the principal approaches. All of them worked. The objective was reached in four years.

Second, there was the ICBM program model. Here, Bendetsen stated, "a single executive was endowed with plenary power bypassing bureaucratic channels. There were several unknowns, each with alternative approaches. Single choices were banned. They were researched and tested in parallel. The objective was obtained in five years." With regard to Apollo, the third precedent, Bendetsen said that "bureaucratic channels were set aside and bypassed. The problem unknowns were staggering. Single choices were banned. Separate approaches were explored and tested in parallel. The objective was reached on time and within original cost estimates."[12]

The memorandum recommended four actions to the president. These were that the president establish special management arrangements as detailed in attachment A to the memorandum, direct the simultaneous pursuit of multiple "technical alternatives," specify systems to be deployed as suggested in attachment B, and issue directives that would sustain the special management arrangements for "at least six years to provide sufficient time to establish the essentials for a transition from a strategy that emphasizes offense to a new strategy that emphasizes defense."[13]

Attachment A, the one of principal concern here, called for the President to issue an executive order that would establish the parameters for the management of the new program. An executive manager reporting directly to the President would control an "executive agency" that would run the new missile defense program. This agency and its director would have authority to

> obligate allocated funds, to enter into contracts, to hire personnel as appropriate, draft government personnel to serve under him as needed, to propose appropriate arrangements with our close allies and to do all things and to take any and all actions necessary and proper to expedite and successfully develop the critical technologies required to deploy the systems delineated by The President, in the shortest possible time.

All offices within the Energy and Defense Departments that could contribute to missile defense efforts were to be at the disposal of the new agency and its leaders. These offices included DARPA and its Directed Energy Office; the Army's Materiel and Readiness Command and Ballistic Missile Defense Organization; the Air Force's Space Command, Space Technology Center, and Systems Command; national laboratories at Livermore and Los Alamos; assistant secretary of energy for military programs; and the

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[12] Memorandum for the President, Final Draft, May 23, 1983, attached to Memorandum for Joseph Coors, Jaquelin Hume, Edward Teller, William Wilson, May 23, 1983, in Bendetsen Papers on High Frontier Panel. With regard to the "numerous drafts," Bendetsen claims to have rewritten the memo "18 to 20" times (Karl R. Bendetsen to Joseph Coors, May 11, 1983, in Bendetsen Papers on the High Frontier Panel.)

[13] Memorandum for the President, Final Draft, May 23, 1983.

appropriate leaders and offices at NASA. None of these offices was to have any authority over the new executive agency.[14]

Where funding was concerned, the memorandum called for the Director of the Office of Management and Budget to expedite funding for the new agency. Furthermore, all funding that was made available immediately; and all future funding would be handled as was covert funding for the CIA. Any requests for personnel or facilities addressed to other offices in the executive branch were to be honored.[15] On July 11, Bendetsen briefed these views to President Reagan and presented the president with a somewhat modified version of the May 23 memorandum.[16]

Bendetsen was not the only Pentagon outsider pushing for special management procedures for SDI. About a month before Bendetsen's July briefing for the President, Senator Malcolm Wallop (R-WY), who had been an outspoken proponent of missile defenses since the beginning of his first term in the Senate, met with Reagan in the White House and proposed several measures to assure success of the new missile defense program. Among these was a recommendation that the president appoint "a Special Assistant of high stature, credibility and expertise to begin coordinating the efforts of DOD, NASA, and DOE leading toward a specific proposal for organizational realignment that would provide greater focus to our technology efforts." A week later on June 15, Judge William Clark, President Reagan's national security advisor, asked Deputy Secretary of Defense Paul Thayer for an appraisal of Wallop's suggestions. In his memorandum to Thayer, Clark stated that when the Pentagon delivered its final report on the studies required by NSSD 6-83, President Reagan wanted to be "postured to move out aggressively with a total coherent program that contains all the necessary actions to implement his initiative. To this end, the President wants to solicit the advice and counsel from many different sources and feels that Senator Wallop's suggestions may offer some constructive means of fulfilling this goal."[17]

Major General Donald Lamberson, executive secretary to the senior interagency group on defense policy (SIG-DP) that was responsible for working SDI-related issues, suggested that Deputy Secretary Thayer reject Wallop's suggestion for a special assistant on the grounds that it was untimely, since the Fletcher Report was not yet finished. Wallop should be thanked for the suggestion and assured that the Pentagon would actively seek the advice of industry and government leaders on how to run the SDI program as soon as the report was completed. At the same time, Lamberson believed that

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[14] *Ibid.*

[15] *Ibid.*

[16] Memorandum for the President, [July 11, 1983], and Karl R. Bendetsen, Memorandum for Mr. Joseph Coors, et. al., October 5, 1983. Both documents were found in Bendetsen Papers on the High Frontier Panel.

[17] William P. Clark, Memorandum for Paul Thayer, "Follow-up to Meeting between the President and Senator Malcolm Wallop," June 15, 1983. Wallop's meeting with Reagan occurred on June 8, 1983.

SDI "is a DoD responsibility and that we are capable of coordinating the efforts of the other agencies and implementing a program to accomplish the President's objectives."[18]

Lamberson's views regarding proprietorship of SDI seem to have been prevalent in the Pentagon's bureaucracies. As we shall see later, when Bendetsen's suggestions were considered in the Pentagon toward the end of 1983, they were rejected on much the same grounds as those Lamberson stated in his draft memorandum from DeLauer to Thayer. But now, let us return to the efforts of the High Frontier Panel to establish a special management structure for SDI.

During early October, Bendetsen and Joseph Coors, the Colorado beer magnate and a member of the High Frontier Panel, continued to push their agenda with regard to a special management structure for SDI. On October 3, they met with Dr. George Keyworth, Reagan's science advisor, and asked him to serve as executive manager of the program; he was the "ideal" person for the job in their view. Keyworth indicated his willingness to support a special management arrangement. Specifically, since Judge Clark was in charge of the SDI project at this stage, Keyworth said he would be willing to help Clark run it. The following day, Coors and Bendetsen met Judge Clark. They urged him to keep the project under the White House and use Keyworth as his assistant, informing Clark that this arrangement was acceptable to Keyworth. Clark "responded well," according to Bendetsen, and indicated that he would consult with Keyworth on this matter.[19]

On October 20, 1983, Bendetsen took his campaign for a special management arrangement to Vice President George Bush by sending Bush a copy of the memorandum he had given President Reagan in July. Additionally, Bendetsen sent the vice president a "paper dealing with the necessity of an early Presidential decision to announce that he has ordered the establishment of special management paralleling Manhattan, etc." He also proposed to Bush "a Council on Assured Survival as orally outlined to you."[20]

Bush forwarded Bendetsen's letter to Admiral Dan Murphy on October 22. The vice president's note to Murphy stated: "This guy came to see me. He is legitimate—his panel looks like Danny Graham's board of directors. Can you check around on this and advise how to handle?"[21] Murphy passed Bush's note to G. Philip Hughes, deputy assistant to the vice president for national security affairs, who on November 7 sent the memorandum for action to Lt. Col. Richard Higgins, military assistant to the executive

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[18] Donald L. Lamberson, Memorandum for Dr. [Richard] DeLauer, Subject: "Follow-up to Meeting between the President and Senator Malcolm Wallop," June 23, 1983, with two attachments: Draft Memorandum from DeLauer to Deputy Secretary of Defense, Subject: "Follow-up to Meeting between the President and Senator Malcolm Wallop—ACTION MEMORANDUM," n.d., and Draft Memorandum for William P. Clark, Subject: "Follow-Up to Meeting Between the President and Senator Malcolm Wallop," n.d.

[19] Karl R. Bendetsen, Memorandum for Joseph Coors, Jaquelin Hume, Edward Teller, and William A. Wilson, October 5, 1983, in Bendetsen Papers on the High Frontier Panel.

[20] Karl R. Bendetsen to Vice President [George Bush], October 20, 1983, in Bendetsen Papers on the High Frontier Panel.

[21] G[eorge] B[ush] to Dan Murphy, hand-written memorandum, October 22, 1983.

secretary in the office of the secretary of defense.[22] Hughes's memorandum interjected the concept of a Manhattan Project management scheme into the Pentagon bureaucracy.

The Battle in the Pentagon: Round I

When one speaks of the Pentagon bureaucracy, one must understand that there is no single monolithic bureaucratic structure that guides the nation's defense program. In fact, there are several distinct bureaucratic elements or sub-bureaucracies involved in making national defense policy. Among the major sub-bureaucracies are the staff of the Secretary of Defense, the Joint Staff headed by the Chairman of the Joint Chiefs of Staff, and the military and civilian staffs of the three major military services. Each of these bureaucracies can have its own perspective and its own agenda on any one issue. This situation is further complicated by the fact that there are also a number of smaller, specialized bureaucratic groups such as defense agencies like the Defense Advanced Research Projects Agency with varying interests in different projects and policies. All of this is to say that the decision making process within the Pentagon can be very complex.

By the time Hughes's memorandum arrived in the Pentagon, the various bureaucracies were already involved in laying out the structure for the new SDI program. An early discussion of the management issue had appeared in a September 6, 1983, memorandum from Robert S. Cooper, DARPA Director, to the under secretary of defense for research and engineering (USDR&E), Richard DeLauer, in which Cooper indicated that Pentagon officials may already have been aware of efforts outside of DOD to establish a special management structure for SDI.

> Either we must decide on a management approach for DABM [Defense Against Ballistic Missiles—an early name for SDI] technology within about two weeks, or management proposals outside of Defense control are likely to be imposed on us. Inside your staff, opinion is that you should create a new agency to manage Defensive Technologies R&D. A Brief four pager drafted by T. K. Jones proposed that approach as the only alternative. That paper should reach you soon. I would like to give my independent views on the issues and broaden the list of alternatives.[23]

Cooper then stated that any management structure selected must be capable of steering a broad R&D program that would involve activities inside and outside DOD and must have unambiguous control of funding. Additionally, Cooper believed that DOD would have to decide whether to establish a large government staff to manage the

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[22] G. Philip Hughes, Memorandum for Lieutenant Colonel Richard Higgins, "Letter from Karl R. Bendetsen," November 7, 1983.

[23] Robert S. Cooper, Memorandum for Under Secretary of Defense for Research and Engineering (unsigned), "Management Options for the President's BMD Technology Program," September 6, 1983.

Figure 4 At a meeting on 11 February 1983, the Joint Chiefs unanimously recommended to President Reagan that the United States expand its missile defense efforts as a response to growing Soviet strategic power. Over the next year, the Chiefs and their staffs participated in the effort that spawned the management structure for SDI. Shown above, starting on the left and proceeding to the right around the table, are Admiral James D. Watkins, Chief of Naval Operations and principal architect of the Chiefs' position on missile defenses; General Edward C. Meyer, Army Chief of Staff; Army General John W. Vessey, Jr., Chairman of the Joint Chiefs; General Robert H. Barrow, Commandant of the Marine Corps; General Charles A. Gabriel, Air Force Chief of Staff; Mr. Robert C. McFarlane, Deputy to the National Security Adviser; President Reagan; and Secretary of Defense Caspar Weinberger. Photograph from BMDO collections.

new program directly or to use only a small government staff augmented by a "contract research organization."[24]

This point was followed by Cooper's views on the makeup of the new missile defense program. This program should involve research on "generic technology, broadly applicable even outside of DABM." Also included should be research programs specifically directed toward the mission of missile defense, some of which were then run by DARPA and the Army. Additionally, the program should include some of the research

[24] *Ibid.*

projects run by other government offices such as the Department of Energy and the National Aeronautics and Space Administration. Furthermore, the new organization would have to manage large scale technology demonstration projects. Cooper then described the challenge of establishing such an organization in words that now seem prophetic:

> A management structure effective in controlling all of this will not be easy to devise nor to gain support for in Defense or outside. The senior manager involved must be a broad gauged person able to command respect both inside the Department and out. He will function at the *Assistant Secretary* level. A sizeable amount of the program content will not readily be extricated from current Service or other agency control. Hence, some method of *indirect* technical, programmatic and fiscal control will be necessary.[25]

Cooper believed that one of the most important factors in the success of the SDI organization would be tight management control, which "in Washington . . . requires independent fiscal control closely connected to the head of a Department. That is one reason [D]ARPA works so well. You and I have the full support of SecDef in deciding what we shall do." Two issues were associated with this approach to management:

> (1) How does an independent authority have effective influence over program content [with] the programming, planning and budgeting authority residing elsewhere (especially with agencies outside of Defense)?
> (2) How can funds earmarked specifically for DABM under SecDef control be made to effectively compete with those associated with other Defense priorities?[26]

With regard to these two points, Cooper made the following comments:

> On the first point, the type of R&E [research and engineering] oversight that currently exists in the tech base will not be adequate. Even the dedicated type management [Maj Gen] Don Lamberson [USAF] has given the Directed Energy programs or the R&AT [research and advanced technology] control of VHSIC [Very High Speed Integrated Circuitry] have not been entirely satisfactory. In my view DABM related funds should flow through the DABM management into Service and Defense agency as well as other agency programs to assure technical responsiveness. Where generic technology is involved, mandatory concurrence on program content should be required. Augmentation of generic technology with DABM funds should be an option of the DABM manager.
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> On the second point, the DRB [Defense Resources Board] is the only organization where all DoD priorities are sorted at the $2B to $3B level. DABM funding levels should be allocated by that body each year.[27]

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[25] *Ibid.*

[26] *Ibid.*

[27] *Ibid.*

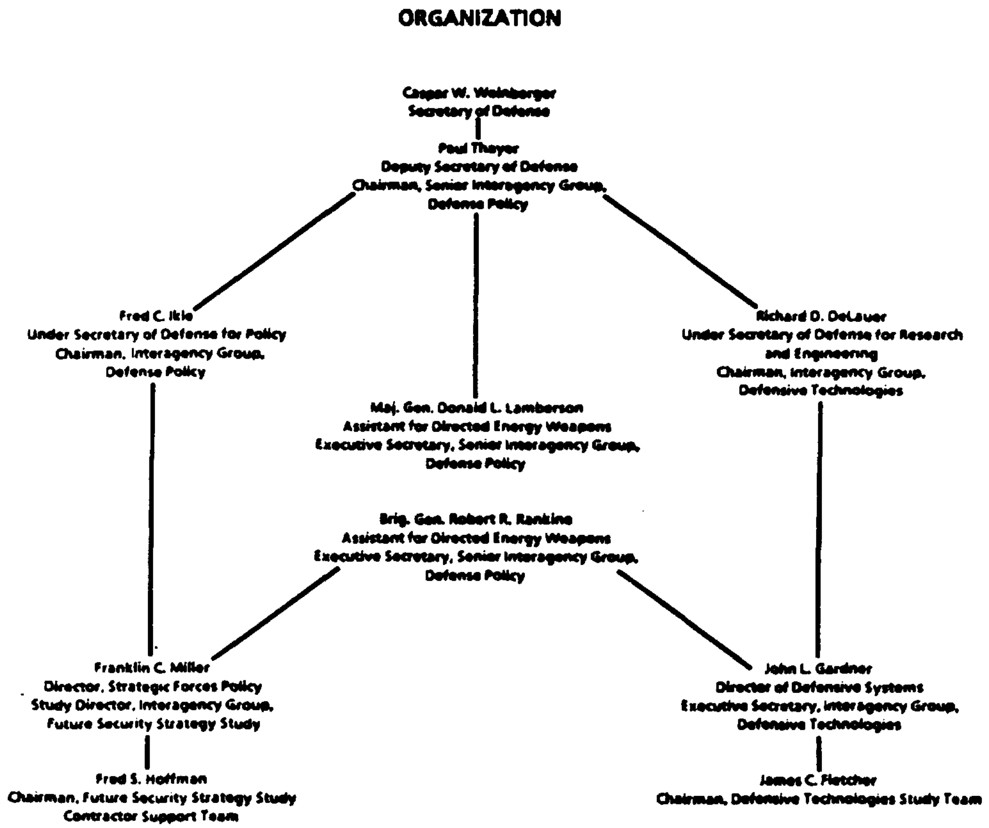

Figure 5 This chart gives an idea of the complexity of the bureaucratic interactions involved in developing the management structure for the SDI program. Although not indicated on the chart, Dr. DeLauer supervised both Major General Lamberson and Brigadier General Rankine. (Source: Department of Defense, "The Strategic Defense Initiative: Defense Technology Study," March 1984, p. 24.)

Beginning at the bottom of the second page of his memorandum and continuing through the third page, Cooper presented a long outline of management alternatives centered around three possible approaches: direct military service control, direct OSD control, and defense agency control. "From a management point of view," Cooper concluded on page four, "any of these three organizational options could work if you imbue them with the features outlined. Without budget and fiscal control as well as technical direction authority none will work. The important thing for you to do is select one and lobby like hell for it now before you are preempted."[28]

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[28] *Ibid.*

Within a few days of Cooper's memorandum, another perspective on the management structure for SDI surfaced. On September 9, the Joint Chiefs of Staff (JCS) issued JCSM-233. As noted earlier, the wording of NSSD 6-83, which chartered the Fletcher and FS^3 studies, also required an annual update of these studies. The update requirement apparently led the Joint Chiefs to believe that the studies chartered by NSSD 6-83 were merely the starting point for a long-term study effort that would eventually lead into a missile defense program that would last for decades. Based on this belief, the JCS formally proposed in JCSM-233 the establishment of Project Defender, which would serve "as the DOD management structure to provide the DOD contribution to the President's annual update of defense against ballistic missiles (DABM), as mandated by National Security Study Directive 6-83."[29]

Project Defender was to be led jointly by the Secretary of Defense and the Chairman of the Joint Chiefs of Staff. Effective October 1, 1983, when the Fletcher and Hoffman studies were submitted to the President in accordance with NSSD 6-83, Project Defender would become the "DOD focal point for DABM activities" and:

> (1) Have the authority to speak for, and make recommendations to, the represented Services/agencies.
> (2) Provide top-level guidance for the accomplishment of studies and reports.
> (3) Monitor implementation of actions initiated as a result of studies.
> (4) Provide [a] recommended DOD position for the annual update to the Secretary of Defense for approval and input to the SIG-DP or to that agency directed by the NSC [National Security Council] to compile the President's annual update.[30]

The executive body of Project Defender would be a review panel chaired by the Director of J-5 (JCS office responsible for strategic plans and policy) and the USDR&E. Working for the panel would be two teams: a policy and strategy study team chaired by a representative of the Under Secretary of Defense for Policy and a development and acquisition study team headed by a representative from the office of the USDR&E. The functions of Project Defender were in no way to trespass the prerogatives of the SIG-DP, which would continue to make all decisions regarding the SDI project unless the NSC assigned the responsibility to another agency.[31]

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[29] Lt. Gen. Jack N. Merritt, USA, Director of the Joint Staff, Memorandum for the Secretary of Defense, "Terms of Reference for Project Defender," JCSM-233-83. Project Defender was apparently discussed as early as May 24, 1983, in a Joint Chiefs briefing. Here, Defender was advanced as a concept for managing and integrating several required studies that dealt with national space policy and strategic defense in its broadest sense which also included air defense against attacking manned bombers. Defender would also oversee those studies required by NSSD 6-83. See "Project Defender," Briefing Outline, [May 24, 1983]. This Project Defender is not to be confused with the missile defense program of the same name that was run by the Advanced Research Projects Agency (ARPA), the predecessor of DARPA, in the late fifties and early sixties.

[30] Merritt, JCSM-233-83, September 9, 1983.

[31] *Ibid.*

While Project Defender seems to have been a good-faith effort on the part of the JCS to manage what it saw as a long-term study effort entailing annual updates of the reports required by presidential directive, JCSM 233 did contain language that suggested its creators may have seen Defender as a possible management structure that would control any missile defense program that might emerge from the NSSD 6-83 studies. For example, the draft terms of reference for the operation of Project Defender stated that the "participation and cooperation" of top Pentagon officials "would make Project Defender an excellent management tool for DOD DABM programs." Furthermore, as already noted, monitoring the "implementation of actions initiated as a result of studies" was listed under the responsibilities of Defender.[32]

On the same day the JCS issued its memorandum 233, Dr. James Fletcher, chairman of the Defensive Technologies Study Team, advised Richard DeLauer of the views on SDI management that his committee planned to present in its final report. The position of the Fletcher Committee was that the SDI had to have a "special management system to succeed." The essential features of such a system would include a single director who would have "responsibility for the execution of the program and the authority and funds to carry it out. It is absolutely necessary that the person has [sic] direct control of the funds required, flexibility in the allocation of the funds and accountability for the outcome." Also, the director should be "dual-hatted" in DOD and the Department of Energy (DOE), that is, his position should give him authority to direct appropriate actions both in DOD and DOE. To be sure the director has sufficient authority, Fletcher said, it "may be necessary to designate him as a new 'Principal Deputy' in OUSDRE." Finally, the SDI should have "the top government procurement priority and the director will need the maximum latitude permitted by the Defense Acquisition Regulations."[33]

On September 19, DeLauer responded favorably to Fletcher's recommendations but suggested several changes. DeLauer did not agree that the director should have the specific title proposed by Fletcher, but DeLauer did recognize the importance of rank and position within the Pentagon bureaucracy. As a result, DeLauer suggested that Fletcher replace his recommendation that the director be a principal deputy in the OUSDR&E with the following statement: "The program should be placed at a level appropriate to the importance of the effort and necessary to insure efficient execution." Additionally, DeLauer saw no reason to state that the SDI director should have maximum latitude within the defense acquisition framework. DeLauer also recommended dropping the "dual-hat" requirement.[34]

DeLauer's September 19 letter suggests that his office was already considering its own approach to the management of the SDI program; it may well have been the approach outlined in an October 11 memorandum from Deputy Secretary of Defense

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[32] *Ibid.*

[33] James C. Fletcher to Richard D. DeLauer, Letter with Attachment, September 9, 1983.

[34] Dick [Richard DeLauer] to James C. Fletcher, Letter with Attachment, September 19, 1983.

Thayer, since this memorandum was almost certainly drafted by DeLauer's office.[35] Here, Thayer made the USDR&E responsible for preparing "a plan for integrated research, development, and acquisition management of the many defensive technology program elements (PEs)." This plan was to "address technical direction, budget control, and contracting authority." The USDR&E was also to prepare tentative program budget decisions (TPBDs) for each PE that was to be included in the "overall defensive technologies program." These TPBDs would "describe the funding and technical content" of the PE "for each of the four generic [program] options discussed at the September 26 SIG-DP meeting." These PEs would then be reviewed by the responsible services and DOD agencies "for comment pursuant to identifying the most prudent funding level for each PE, consistent with the defensive technologies initiative, other missions that may compete for those technologies, and fiscal responsibility."[36]

DeLauer assigned responsibility for the SDI management tasks outlined in Thayer's October 11 memorandum to Brigadier General Robert R. Rankine, Jr., U.S. Air Force, who had replaced Lamberson as assistant for directed energy weapons in DeLauer's USDR&E office. Soon thereafter, Rankine began asserting his role as the principal authority over the Pentagon's efforts to develop an organization and program for SDI. On October 21, Rankine addressed a memorandum to several Pentagon officials asking them to designate someone who could devote considerable time between October 21 and November 7 to an effort to identify and analyze "the alternatives for management" of SDI. This group would prepare a report on management options and submit it to the Defensive Technologies Executive Committee (EXCOM) by November 7. At the group's first meeting scheduled for October 23, the Defense System Management College would present a briefing based on a study completed earlier. Those attending the meeting were to be ready to discuss "the characteristics that a Defensive Technologies management organization must, should and could have, in order to function effectively and efficiently." Representatives were to advise the group if their offices had a management concept that should be briefed to the group and to state when a briefing on such a concept could be given. Additionally, Rankine called for the appropriate representatives to arrange for briefings on the management concepts used by "DARPA, DNA [Defense Nuclear Agency], the VHSIC, and Cruise Missile Project Office."[37]

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[35] While I was unable to find the USDR&E correspondence relating to Thayer's October 11, 1983, memorandum, I have documented several cases of USDR&E drafting correspondence relating to SDI for the signature of Thayer. These examples are the basis for my conclusion that someone in USDR&E, probably Rankine, drafted the October 11 memorandum for Thayer.

[36] Paul Thayer, Memorandum for Chairman of the Joint Chiefs of Staff, Under Secretaries of Defense, Assistant Secretary of Defense (Comptroller), and Director of Program Analysis and Evaluation, "Defensive Technologies," October 11, 1983.

[37] Robert R. Rankine, Jr., Memorandum for Assistant Secretary of the Army (Dr. Norwood), et. al., October 21, 1983.

With SDI now moving toward program status and USDR&E developing its own plans for managing this program, it is not surprising USDR&E's staff moved to establish restrictions on the JCS's Project Defender proposal, which as we have seen had implications that went beyond merely managing update studies on the state of missile defense research. Thus, General Rankine prepared a memorandum on Project Defender that was addressed to Paul Thayer and signed out of USDR&E by James P. Wade on October 24. This document advised Thayer that the management structure established by Thayer's October 11 memorandum was adequate for the current situation and recommended that Thayer issue a memorandum that would circumscribe Project Defender.[38]

On October 31, Thayer signed a memorandum taking the position on Project Defender recommended by Rankine and Wade. This memorandum stated that Project Defender would be a "valid and useful approach to managing the future studies that will result from our work on NSSD 6-83," but "because we will need to concentrate over the next two months on programmatic and budgetary issues related to the President's initiative, I would prefer to delay the organizational decisions in support of follow-on NSSD 6-83 studies until January 1984." Until that time, Thayer continued, the Defense Technologies EXCOM, "working with the support and participation of the Services and Defense Agencies, will conduct the necessary reviews, evaluations, and analysis to permit the refinement of a recommended approach." Thayer stated emphatically that Project Defender would have no management authority over SDI: "I want to make clear, however, that should Project Defender be selected as a means for annual update of strategy studies and technology plans, it would *not* [italics in original] have authority on programmatic and budgetary issues." These matters would continue to be handled within the PPBS system. Furthermore, program management would be handled by the Under Secretary of Defense for Research and Engineering.[39]

About a week after Thayer issued his memorandum on Project Defender, the EXCOM meeting called by Rankine took place. Briefing slides from this November 7 meeting indicate that five patterns of management organization were considered: central oversight with decentralized execution, designating a military service as the lead management agency, central management with execution largely decentralized, centralized management and execution, and program representative reporting to the White House level. The minutes of this meeting stated that the EXCOM decided to delay decisions on the management issue until a "White House decision on program scope is made." While the management decision was to be delayed, work on other aspects of the new missile defense program would continue. However, the EXCOM made it clear that the assignment of responsibility for writing an issue paper on a topic did not mean that an office

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[38] James P. Wade, Jr., Memorandum for Deputy Secretary of Defense, "Project Defender—ACTION MEMORANDUM," October 24, 1983.

[39] Paul Thayer, Memorandum for Chairman, Joint Chiefs of Staff, "Terms of Reference for Project Defender (JCSM-233-83, 9 September 1983," October 31, 1983.

preparing the paper was being assigned responsibility for a role or mission addressed in that paper.[40]

Another EXCOM meeting was scheduled for November 30, but was cancelled. However, copies of viewgraphs that were prepared for the meeting show that the principal issue worrying the military services and DOD agencies was "who should be in charge of the various tasks." These viewgraphs also suggest that where this central issue was concerned, Rankine faced a number of conflicting views. The Army believed that the various elements of the program "should be centrally managed" with the Army having primary responsibility for "the entire SATK [surveillance, acquisition, tracking, and kill assessment] program, all systems concepts, battle management, and lethality and vulnerability." The Army also believed that the DEW program should be centrally managed by DARPA with support from the services. The Air Force wanted responsibility "for all space-based DABM system elements." Additionally, the Air Force believed that it should be in charge of "systems concepts and battle management." DARPA wanted to decide responsibilities at a later time.[41]

Thus, by November 30, 1983, when Secretary Weinberger attended a National Security Council meeting at which the central topic was SDI, the Pentagon was deeply involved in working out a management concept for the new missile defense program. Although the Pentagon bureaucracies were far from agreeing on all points, there was agreement on at least one point: The new missile defense program should be managed within the Department of Defense. Weinberger gave this message to the NSC on November 30 when he briefed on an SDI study completed by the Senior Interagency Group—Defense Policy. One conclusion of this study was that "a central management organization is of critical importance and that this responsibility would be most efficiently and effectively executed if assigned to the Department of Defense with the Senior Interagency Group—Defense Policy (Defensive Technologies) (SIG-DP) functioning in a continuing oversight role."[42]

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[40] Briefing Slides, November 7 EXCOM Meeting; Robert R. Rankine, Jr., Memorandum for the Record, Subject: "Minutes of 7 November 1983 Meeting of Defensive Technologies Executive Committee (EXCOM)," November 7, 1983; "Explanatory Notes: Method Used to Prepare Defense Against Ballistic Missiles (DABM) Issue Papers," attachment to Richard DeLauer, Memorandum for Secretaries of the Military Departments, et. al., Subject: "Defense Against Ballistic Missiles (DABM) Issue Papers—Action Memorandum," November 8, 1983. Thayer's signature at the bottom of the minutes indicates his approval.

[41] Collection of hard copies of briefing viewgraphs titled "Defense Against Ballistic Missiles (DABM): Executive Committee (EXCOM)," November 30, 1983. The word "cancelled" in parentheses appears after the date on the title page of the viewgraph collection.

[42] Francis X. Clines, "Reagan Reported to Agree on Plan to Repel Missiles," *New York Times*, December 1, 1983, p. A1; "SIG DP Memorandum for the President: Prospects for a National Strategy Based on Reliance on Defense Against Ballistic Missiles," p. 18. This document is TAB B to Robert M. Kimmitt, Memorandum for Mr. Charles Hill, et. al., "NSC Meeting on Strategic Defense, Wednesday, November 30, 1983," November 28, 1983. The same basic points on management appear on p. 3 of "NSC Meeting of November 30, 1983: Defense Against Ballistic Missiles, Secretary's Talking Points," n.d.

Round II: Demise of the Manhattan Project Concept

A fairly complete briefing on the results of the November 30 NSC meeting was provided to Karl Bendetsen, perhaps by the president's science adviser who attended the meeting. Bendetsen was not happy with what he heard. He had yet to receive a reply to his letter to the vice president, but the report of the NSC meeting was a clear indication that the Manhattan Project scheme for managing SDI was near death, if not dead already. The report contained no mention of a special management structure for SDI. Weinberger, Bendetsen reported to four of his colleagues on the High Frontier Panel, strongly supported developing missile defenses. However, it was clear that Weinberger expected "the Defense Department to be given a directive to undertake the project." Bendetsen also reported that McFarlane assigned responsibility for the missile defense program to his new deputy, Rear Admiral John M. Poindexter. Poindexter supported the new program, but Bendetsen referred to him as a "two-star Admiral" who "very much wants to become a three-star admiral. This precludes any possibility that he would recommend special management outside of the Pentagon."[43]

About the time of the November 30 NSC meeting, General Rankine was drafting a formal reply to Bendetsen's letter to the vice president; it would not clear the Pentagon until near the end of 1983. Rankine actually prepared two letters. One was for Secretary Weinberger's signature and was to be used by Weinberger to send Bush a proposed response to Bendetsen. The second letter was the actual draft of a letter from Bush to Bendetsen. The latter was vague and general; the former outlined for the vice president the Pentagon's rationale for rejecting a Manhattan Project management arrangement for SDI.

Rankine's draft letter to the vice president advanced a three-part argument against Bendetsen's management scheme. To begin with, "the SDI initiative is far broader than the Apollo and Manhattan projects to which it is frequently compared." Furthermore, "the development work involved is deeply intertwined with other DOD development requirements." Therefore:

> [A]ttempts to manage DOD programs from outside the Department would result in serious problems. If the SDI reaches implementation, we must insure that the management approach encourages close coordination between the laboratories, procurement agencies, and operational commands. The detailed interaction between these functions is only understood and possible within the Department.[44]

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[43] Clines, "Reagan Reported to Agree on Plan to Repel Missiles," p. A1; Karl R. Bendetsen, Memorandum for Joseph Coors, Jaquelin Hume, Edward Teller, and William Wilson, December 1, 1983, in Bendetsen Papers on the High Frontier Panel.

[44] R[obert R.] Rankine, Covering Brief for the Under Secretary of Defense for Research and Engineering, [December 1983]. Although the Covering Brief is undated, it carries in the upper right hand corner the statement: "Resubmitted 12/21/83." Also, one copy of the Covering Brief has the coordination of RSC [Robert S. Cooper], OASD (R&T) with the date December 16, 1983. The word "resubmitted" refers to the fact that the original "package" sent to Weinberger's office on November 29, called for the Secretary to call the Vice President, talk to him about the response to Bendetsen, and then send the draft response without a cover letter. The "package" was returned from the Secretary's office on December 9 with a request that a cover letter be drafted from Weinberger to Bush.

On January 13, 1984, Bush signed a letter to Bendetsen that was practically the same as the one drafted by Rankine.[45]

Rankine's draft letters notwithstanding, some prospect that a special, non-DOD management arrangement might be developed existed as late as the end of December 1983. On December 27, Admiral John Poindexter asked the Pentagon to comment on a draft national security decision directive that would formally establish the SDI program.[46] According to the draft NSDD, the program was to be established in the Defense Department and run by a program manager who would be appointed by and report to the Secretary of Defense. Thus, this draft NSDD indicates clearly that a major recommendation from Bendetsen and the High Frontier Panel had been rejected. There would be no new missile defense agency outside the Pentagon. However, there was a provision for the program manager to report periodically to the President on progress toward the program's objectives. Weinberger took issue with this requirement in his response to Poindexter's memorandum. In the secretary's words: "Since the Program Manager is to report to the Secretary of Defense, and because of the critical importance of this effort, it seems more appropriate for the Secretary rather than the Program Manager to report to the President." Weinberger also recommended against the establishment of a Strategic Defense Senior Review Group. According to the draft NSDD, this group would have been chaired by the president's national security adviser and was to "monitor the status of the strategic defense initiative." Its membership would have included representatives of the Department of State, The Department of Energy, the Defense Department, the Joint Chiefs of Staff, CIA, NASA, ACDA, OSTP, and OMB. The requirement for this oversight group may be a reflection of some of the later recommendations Bendetsen made to Vice President Bush and Judge Clark. Weinberger argued that this new review group would be redundant, since the Senior Interagency Group-DP already performed this function and should continue to do so.[47]

The death knell of the Manhattan Project management scheme was formally sounded when Reagan signed National Security Decision Directive 119 on January 6, 1984, one week before Bush sent his letter to Bendetsen. The last vestiges of special management arrangements similar to those advocated by Bendetsen had been removed from the final version of the NSDD, which established the basic framework for launching the Strategic Defense Initiative. The program Reagan outlined here was to be managed by the Defense Department with Weinberger being responsible for the program. Reagan asked the secretary of defense

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[45] George Bush to Karl R. Bendetsen, letter, January 13, 1984, in Bendetsen Papers on the High Frontier Panel.

[46] John Poindexter to [Caspar] Weinberger, handwritten memorandum, December 27, [1983].

[47] Caspar Weinberger, Memorandum for Assistant to the President for National Security Affairs, Subject: "Strategic Defense Initiative," December 30, 1983; Draft NSDD, "Strategic Defense Initiative," n.d. Regarding the Review group provided for in the draft NSDD, this may represent the influence of Bendetsen and the High Frontier Panel. If that is the case, we see here the formal rejection of one of the means by which Bendetsen would have brought outside influence to bear on the new SDI program.

to create a specific management structure to implement the program. The program manager shall report directly to the Secretary of Defense regularly and shall be provided with authorities and responsibilities commensurate with the high priority of this initiative. The Secretary of Defense shall recommend the level of funding required each year to meet program objectives and be responsible for presenting the request to Congress. The Secretary of Defense shall periodically report progress in achieving program objectives to the President.[48]

With this decision from Reagan that DOD would manage the SDI program, it was time for the Pentagon to begin developing a management structure in earnest.

Round III: The Emergence of the April 1984 SDI Charter

Over a period of about two weeks following the issuance of NSDD 119, USDR&E worked informally with the military services and various DOD agencies and staff offices to develop a draft charter for the SDI management organization. As January 1984 was drawing to a close, DeLauer felt the coordination process had advanced to the point where it was appropriate to solicit Secretary Weinberger's views on the management approach his office was developing. Therefore, on January 23, he sent to Weinberger a draft charter that incorporated decisions DeLauer had made, along with a number of the recommendations and comments on the charter that had been submitted by various Pentagon offices. DeLauer informed Weinberger that the draft charter incorporated the provision of NSDD 119 that called for the Secretary of Defense to select the program manager who would then report to the Secretary of Defense. He also advised Weinberger to appoint the new program manager as soon as possible and recommended Lt. Gen. James A. Abrahamson, USAF, for the job.[49]

In addition to the charter's provisions governing the appointment of the director and his relationship to the Secretary, it would have established a management structure composed of three elements: "(1) a committee structure for interdepartment/service/agency review and oversight of the SDI; (2) a program management office to guide the program on behalf of the Secretary of Defense; and (3) a program element/project/task structure for decentralized execution of the program by the participating Departments, Services, and Agencies." A program manager would head the "Strategic Defense Technology Office (SDTO)" which would be "a small OSD staff element of no more than 15 professional staff members including an Assistant Program Manager for System Concepts and Analysis and Assistant Program Managers for each of the five major technical areas of the Strategic Defense Initiative." The assistant program manag-

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[48] Ronald Reagan, National Security Decision Directive Number 119, January 6, 1984.

[49] Dick [Richard DeLauer], Memorandum for the Secretary of Defense, "Charter for Management of the Strategic Defense Initiative—ACTION MEMORANDUM," January 23, 1984. Attached to this memorandum are a copy of the draft Department of Defense Directive, "Management of Strategic Defense Initiative Research and Technology Program," n.d., and Robert R. Rankine, Jr., Memorandum for the Undersecretary for Research and Engineering, January 20, 1984.

Figure 6 The first director of the new missile defense organization was Lt. Gen. James A. Abrahamson shown here shaking hands with President Reagan. When chosen for the director's position, Abrahamson was completing a tour at NASA where he oversaw the first ten flights of the Space Shuttle. Photograph from USAF collections.

ers would be people already assigned to USDR&E who would perform their SDI work as an additional duty. The duties of the various elements in this management scheme were spelled out in a section of the charter, as were the procedures for executing the SDI program.[50]

Word of DeLauer's management concept quickly leaked out of the Pentagon, and dissatisfaction with this concept quickly surfaced. An editorial in *Aviation Week and Space Technology* charged that

> while specific responsibilities have been assigned to various services, there is no overall direction yet, no simple line of authority to the top. Richard D. DeLauer, under secretary of defense for research and engineering, has assigned ground-based elements to the Army, space-based elements to the Air Force and has brought in the

[50] DeLauer, "Charter for Management."

Defense Nuclear Agency to handle aspects such as hardening. Otherwise, the organization codifies the research apparatus that had already divided directed-energy weapons and antiballistic missile research among the services.[51]

Additionally, Senator Malcolm Wallop (R-WY) was reportedly unhappy with the Pentagon's efforts to establish a management structure for SDI and wrote to Weinberger expressing his displeasure.[52]

In addition to the dissatisfaction in the world outside the Pentagon, there was considerable opposition to DeLauer's charter inside "the building." The charter was in fact a compromise document that papered over a number of major sticking points which had surfaced in the coordination process;[53] and soon after it was sent to Weinberger, several critiques of the draft were sent to USDR&E. The Joint Chiefs, for example, raised a number of issues in a February 1 memorandum. Among these were:

- Some provisions of the draft seemed to be "inconsistent with the stated objectives and the requirements of National Security Decision Directive Number 119."
- No specific relationship was established between the SDI program manager and "DOD organizations responsible for the determination of strategy, operational requirements and plans." The SDI program manager "should be required to seek the direction of the Joint Chiefs of Staff for those aspects of his responsibilities that are related to or touch on the development of operational concepts, requirements and, strategy."
- The programming and budgeting process appeared "convoluted and unnecessarily complex."
- An advisory committee made up of representatives of the JCS, Services, and defense agencies should "advise and assist the SDI Program Manager in determining program direction and task assignments, and make Service/Agency recommendations on resource priorities." This group should also "assist in the preparation of programs for Program Objective Memorandum submission and submission of budget estimates." (This advisory group would seem to be very similar to the advisory committee recommended under the JCS's Project Defender.)
- "The 'dual hatting' of Assistant Program Managers [having officials in the USDR&E office responsible for both USDR&E work and SDI work] was not in keeping with the uniqueness of the Program Manager's role and his direct relationship with the Secretary of Defense." These assistants should be assigned to the "Office of the Strategic Defense Initiative Program Manager on a full time basis."

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[51] William H. Gregory, "Reagan's Space Challenge," *Aviation Week and Space Technology*, January 30, 1984, p. 11.

[52] *Ibid.*

[53] Robert R. Rankine, Jr., Memorandum for ASD (C3I), et. al., "Management of the Strategic Defense Initiative," January 23, 1984. Here, Rankine thanked the OSD staff for its work on the SDI charter and noted that "some" of the staff's comments "were contentious with those submitted by the Services and Defense Agencies."

- DOD did not have the authority to assign in one of its directives the responsibility for a function throughout all areas of the government.
- "Establishment of the SDI PM [program manager] as a single point of contact within the DOD is too broad and could be interpreted as including policy, plans, strategy, and operational requirements."

Attached to this memorandum were three pages of specific changes that the JCS thought should be incorporated in the final version of the charter.[54]

It was also around the beginning of February that General Abrahamson, already mentioned as a possible director for the new missile defense management office, addressed a letter to DeLauer in which the general presented his views on how the new program should be run. He argued that the missile defense program office should be "dedicated to the SDI and made up of 60 to 80 of the best managers and planners available. . . . The Program Office should be located in or near Washington, but not necessarily in the Pentagon. An office should be maintained within OSD." He further stated that "the budget should be centrally controlled with most major tasks delegated for service execution." Moreover, "certain joint planning or demonstration efforts may be centrally managed. Streamlined procedures, execution and reporting must be utilized at all levels. The central control should be considered a temporary measure due to the broad interservice character of the SDI. When possible, both funding and development or deployment responsibility should be returned to the services."[55]

Another exposition of the difficulties with the draft charter appeared in mid-February, this one in a memorandum co-authored by Fred Ikle, under secretary of defense for policy, and DeLauer. This memorandum and its attachments detailed the disagreements among the Pentagon bureaucracies concerning various provisions of the charter. Among the major points presented were:

- The dual hatting scheme "was not in keeping with the uniqueness of the Program Manager's role and his direct relationship with the SECDEF. In the spirit of . . . NSDD 119 and the preliminary portions of the draft [SDI charter], it seems more appropriate that these individuals be assigned to the Office of the SDI Program Manager on a full time basis."
- There was considerable disagreement over the matter of fiscal control of the new program.
- There were different views as to whether or not the SDI program manager would be allowed to "shift funds within program elements across service and agency lines."

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[54] Maj. Gen. George B. Crist, USMC, Vice Director, Joint Staff, Memorandum (DJSM 197-84-1 Feb 84) for the Under Secretary of Defense for Research and Engineering, "Management of the Strategic Defense Initiative (SDI)," February 1, 1984.

[55] James A. Abrahamson, Memorandum for the Under Secretary of Defense Research and Engineering, through the Vice Chief of Staff, USAF, "Strategic Defense Initiative," n.d. [ca. February 1, 1983].

In addition to the comments spelled out in this document, a note on the memorandum indicates that Ikle had "some major reservations regarding the SDI management charter" which he forwarded "directly to Dick DeLauer."[56]

Clearly, the Pentagon was having trouble reaching a consensus on how the SDI program should be managed. Continuing disagreements over the SDI management structure could scarcely have been reassuring to the top DOD officials responsible for implementing President Reagan's vision, even if these officials trusted the Pentagon's bureaucracies. The secretary of defense, for one, did not trust the military services.

Although Secretary Weinberger knew that any one of the three military services would have been happy to manage the program, he also recognized these services contained elements that would be fearful of the possibility that SDI might draw money away from more traditional weapons programs that were "closer to their hearts," as Weinberger put it. In the defense secretary's mind, it was essential to establish a new, centralized organization to manage the program and then place this organization directly under his own control so that he could "block attempts that I knew would be made to divert resources and support from strategic defense, or to slow or dilute the Department's commitment for the Strategic Defense Initiative."[57] It was Weinberger, more than anyone else, who was responsible for turning Reagan's vision into a functioning

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[56] Fred C. Ikle and Richard D. DeLauer, Memorandum for the Secretary of Defense, "Strategic Defense Initiative—ACTION MEMORANDUM," March 13, 1984, with attachment 2 and tabs A-E. TAB A was not discussed in the text because it focused on funding levels rather than organizational-managerial issues.

[57] Caspar W. Weinberger, *Fighting for Peace: Seven Critical Years in the Pentagon* (New York: Warner Books, 1990), pp. 310-11. With regard to the issue of service control of funding, General Robert R. Rankine stated that at one point Lt. Gen. James A. Abrahamson had a "fairly heated debate" with General Lawrence Skantz, vice chief of staff of the Air Force, over the issue of who should control funding for the SDI program. Skantz was "quite adamant" that "the funds needed to remain in the services and under the services' control so that they could compete with other service priorities." Rankine went on to say that he believed Skantz's position "represented a point of view which was held by all the [military] services, that you shouldn't fence programs from the prioritization process and that if you did you might end up with irregularities or unevenness, mal-programming of funds because they would not have been given the opportunity to compete with the fighters and battleships and what have you." (Rankine, Interview with Donald R. Baucom, Pentagon, Washington, D.C., July 28, 1987, pp. 13-14.) For a discussion of military service attitudes towards weapons procurement, see Builder, *Masks of War*.

program. And he was determined to keep the bureaucracies of the Pentagon from stifling SDI by gerrymandering the organization that would manage the program.[58]

It was now early March. Almost a year had passed since Reagan announced his vision of a missile defense system that could make nuclear weapons "impotent and obsolete." The Pentagon's only plan for managing the program, DeLauer's charter of January 23 was unacceptable. Weinberger himself had expressed dissatisfaction with SDI management plans in a handwritten note of March 7: "We must be sure we do not do anything that hampers the ability or flexibility of the manager [of the new office]—until we find him."[59] A further manifestation of dissatisfaction emerged during a meeting on March 30 of the SDI Executive Committee when it became clear that "the SDI charter and the management procedures discussed were generally . . . too complex and unwieldy for a fast-paced, Presidential priority program."[60] At this point, the Pentagon's top leadership seems to have taken over the process of developing a plan for SDI's management structure.

On April 18, 1984, the new Deputy Secretary of Defense, William H. Taft, IV, sent a simplified charter to the principals involved in developing the structure for the missile defense initiative, asking that they complete their review and return their comments to Taft by April 20 so that the charter could be finalized by April 24 when Senator John Warner's Subcommittee on Strategic and Theater Nuclear Forces was to begin special hearings on missile defenses.[61]

On April 24 Weinberger issued a memorandum that established the new Strategic Defense Initiative Organization (SDIO) and spelled out the organization's authority. As in the earlier charter, the SDIO Director was to be appointed by and report to the Secretary of Defense. However, a comparison of the April 24 memorandum with the January

[58] Simon P. Worden, Interview with Donald R. Baucom, Pentagon, Washington, DC, May 22, 1987, pp. 17-19, claimed that Weinberger specifically directed that the new missile defense organization would have control of SDI funding. Worden stated that the critical moment came at a meeting that Weinberger just happened to walk into about the time the meeting was over. Worden, who said he was present at the meeting, stated that the military services had just about managed to gain acceptance of the idea that they would control SDI's funding when Weinberger entered. After Weinberger was briefed on what had been going on during the meeting, Brig. Gen. Robert Rankine spoke up and advised Weinberger that the critical issue in managing the SDI program was control of the budget. To this Weinberger responded that the SDI director must have control of the SDI budget. Worden stated that Rankine's speaking out on the matter of the budget was "one of the gutsiest things I have ever seen." What made Rankine's act courageous was the fact that although he was a junior general, he spoke out against a position that the senior Air Force leadership had taken—that funding for missile defenses should be controlled by the military services. When asked specifically about this meeting, Rankine did not recall these events. See Rankine, Interview, July 28, 1987, pp. 14-15. With regard to the approximate date of the meeting in which Weinberger intervened, Worden was vague. He stated that this "meeting came in June after William H. Taft, IV, had just taken over as the deputy secretary." Taft assumed his duties in February; June is not just after Taft had taken over. Worden may have had in mind the March 30, 1984, meeting of the SDI Executive Committee.

[59] Cap [Weinberger], Handwritten Note, March 7, 1984.

[60] William H. Taft, IV, Memorandum for Service Secretaries, Chairman of the JCS, Service Chiefs, et. al., "Strategic Defense Initiative Charter," April 18, 1984.

[61] *Ibid.*

23 draft charter makes it apparent that in a number of other ways the April memorandum increased the independence and authority of the SDIO Director. For one thing, it made the Director of SDIO the central figure in developing and managing the SDIO program—he was to have "overall responsibility for managing the program" and "shall organize a staff, reporting to him, to assist in managing" the program. The members of this staff would be assigned to a new defense agency, the Strategic Defense Initiative Organization. The Director was also authorized to establish his own advisory panel to support him "in technical and other areas critical to the success" of the program. Although Weinberger's memorandum continued the existence of OSD's EXCOM to provide "DOD oversight and guidance for the internal management of the program," it specified that the SDIO Director would serve as the executive secretary for the EXCOM. Moreover, the Director was "responsible to the SecDef for coordinating and executing" the SDI program "within the Planning, Programming, and Budgeting System (PPBS)." Finally, the Director was to serve as a member of the Defense Resources Board (DRB) whenever that body was considering matters related to strategic defense.[62]

With regard to the strategic planning process for the SDI program, the SDIO Director was required to present to the EXCOM an "integrated SDIP [SDI Program] Program Objective Memorandum (SDIP-POM) for review prior to submission to the DepSecDef through the DRB. The SDIP-POM will be coordinated through the Service and Defense Agency POM process." However, the memorandum specified that "programs in the SDIP elements will not be available for tradeoff to meet other Service or Defense Agency needs except upon decision of the DepSecDef." The Director would be responsible for the execution of the SDI program and would work out the structure of the program with the services and defense agencies. He would have authority to issue "Program Direction and request appropriate management and progress reports" and was authorized to "exercise direct contracting authority" as required.[63]

Weinberger's memorandum was the authority under which the SDI Organization operated until a formal charter was issued in February 1986.[64] The memorandum had purposely been kept general to allow the first SDIO Director, General James Abrahamson, the latitude and authority he felt he needed to manage the SDI program. Weinberger and Abrahamson had agreed that a more formal, detailed charter would only be issued after Abrahamson had run the program long enough to understand what authorities and support he needed.[65]

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[62] Caspar W. Weinberger, Memorandum for the Deputy Secretary of Defense, Secretaries of the Military Departments, et. al., "Management of the Strategic Defense Initiative," April 24, 1984.

[63] *Ibid.*

[64] Department of Defense, Directive 5141.5, "Strategic Defense Initiative Organization," February 21, 1986.

[65] James A. Abrahamson, Interview with Donald R. Baucom, Pentagon, Washington, DC, November 3, 1988, pp. 1-2.

Conclusion

Two basic models bounded the debate over the organization that should be established to manage the Strategic Defense Initiative. One extreme was the Manhattan Project model advocated principally by Karl Bendetsen and his High Frontier Panel. This group of men firmly believed that America faced a crisis in the form of a grave threat posed to the United States by the powerful strategic nuclear force structure that had matured by the early 1980s to the point where the Soviets possessed a hard-target kill capability that threatened the survivability of U.S. deterrent forces. The appropriate way to meet this growing threat, they felt, was to develop missile defenses through a crash program run by a manager with direct access to the President. Such a program was the only way to overcome the impediments of bureaucracy that were sure to slow the SDI program if not kill it altogether.

At the other extreme was the position taken by elements of the established Pentagon bureaucracy. Confident of their own ability to handle the major new missile defense program and perhaps feeling less the sense of urgency exhibited by Bendetsen and his colleagues, this faction would have incorporated the SDI program into the Pentagon's established organization by leaving the various missile defense programs spread among the various Pentagon offices and merely increasing the funding available to these offices.

In the end, top civilian leaders, concerned about the complexities of the organizational structure recommended by the Pentagon bureaucracies, forged a compromise management approach. The central figure behind the compromise was Caspar Weinberger. He thought that the SDI program belonged within the Pentagon. At the same time, however, he believed that the Pentagon's established bureaucratic structure could not adequately handle SDI. His solution was to establish a special organization directly under the protective wing of the Defense Department's top civilian leadership and give that organization all the powers it needed to carry out the SDI program, especially the control of SDI funding.

Indeed, control of funding was probably the most critical issue. If those who wanted merely to integrate the SDI program into the established bureaucracy had prevailed, existing offices in the military departments and defense agencies would have continued to control portions of the missile defense program, including the additional funding that was sure to come with a presidentially-favored program. Under this arrangement, offices that were part of established bureaucracies such as those of the military services, each with its own larger agenda, would have had power to set the direction for the SDI program and to reallocate at least part of the additional funding for other, more traditional programs with strong institutionalized constituencies.

On balance, then, Reagan administration officials were largely successful in establishing a special, if not a revolutionary, management structure for the president's new program. A special SDI management office with control over funding for missile defense projects could fend off funding raids against missile defense projects and assure that the direction of the program was that favored by the president and his top officials.

Index

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